RELIABILITY AND VALIDITY OF PHYSICAL ACTIVITY MEASUREMENTS IN VIETNAM

by

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Statement of originality and access authority

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Statement of authorship

This thesis includes papers for which Au Bich Thuy (ABT) is not sole author. ABT took the lead in this research in that she designed the research, undertook fieldwork, analysed the data and wrote the manuscripts. She was, however, assisted by the co-authors. The contributions of each author are detailed below.

1. The STEPS papers (reported in Chapter 2):

Pham LH, **Au BT**, Blizzard L, Truong NB, Schmidt MD, Granger RH, Dwyer T. Prevalence of risk factors for non-communicable diseases in the Mekong Delta, Vietnam: results from a STEPS survey. *BMC Public Health.* 2009 12 Aug;9

Contribution of each author:

PHL was responsible for obtaining approvals for the study, contributed to the design and conduct of the study, interpretation of the data and revising the manuscript.

ABT contributed to the design of the study, prepared with LB an application to The Atlantic Philanthropies for funds to undertake the study, supervised the field work including training of data collection staff, administered the questionnaires, was responsible for data management including supervision of data entry, with LB undertook all data analyses and contributed to data interpretation, composed the drafts of the manuscript, and coordinated revision of the manuscript.

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MDS contributed to interpretation of the data and to revising the manuscript.

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2. The GPAQ paper (reported in Chapter 3):

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Contribution of each author:

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4. The smoking and hypertension paper (reported in Appendix 6A):

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ABT contributed to the design of the study, prepared with LB an application to The Atlantic Philanthropies for funds to undertake the study, supervised the field work including training of data collection staff, administered the questionnaires, was responsible for data management including supervision of data entry, with LB undertook all data analyses and contributed to data interpretation, composed the drafts of the manuscript, and coordinated revision of the manuscript.

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Date 23-11-2010

Abstract

Mortality from non-communicable diseases (NCD) has increased in Vietnam in recent decades. Relatively little is known about the prevalence of risk factors for NCD in Vietnam, particularly for rural populations living outside the two major cities of Ha Noi and Ho Chi Minh City. The measurement of physical inactivity, an established risk factor for disease in Western populations, has not been attempted. The principal aim of this thesis was to test the reliability and validity of several methods of measuring physical activity in the Vietnamese population. A secondary aim was to investigate the prevalence of physical inactivity and other NCD risk factors in a population-based sample of rural Vietnam.

A population survey (n=1978) was conducted in 2005 in Can Tho in the Mekong Delta of southern Vietnam, using the STEPS methodology developed by the World Health Organisation. Measurements of physical activity were made using the Global Physical Activity Questionnaire (GPAQ). GPAQ is a modified version of the International Physical Activity Questionnaire (IPAQ). A sub-sample (n=251) of participants had multiple measurements of physical activity using GPAQ, IPAQ, pedometers, and physical activity records (PAR).

The key findings were:

1. The prevalence of NCD risk factors in the dominantly rural sample were very different from those previously reported for big city samples from Ha Noi and Ho Chi Minh City.
2. Work activity constituted 80% of total moderate and vigorous activity, and 33% of men and 40% of women were classified as inactive.
3. The modifications of IPAQ in the design of GPAQ have improved the physical activity estimates for those with stable work patterns, but, overall, both questionnaires had modest reliability and validity in estimating physical activity.
4. It was feasible to obtain a superior estimate of physical activity using at least three days of pedometer wear.
5. The use of pedometers was culturally acceptable to the local population. The involvement of health volunteers was critical, but they require constant supervision.

6. Tobacco smoking, a potential confounder of the association between physical activity and NCD risk indicators, was associated with hypertension in a dose-response fashion.
7. Physical activity measured by GPAQ was associated with total cholesterol and, for men, with body composition and blood glucose. Work activity was the main contributor to these associations.

For Vietnam, the GPAQ modifications of IPAQ have been only partly successful. Objective measurement by pedometers is feasible and culturally acceptable, and should be encouraged.

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Au Bich Thuy.

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List of abbreviations

ANOVA	Analysis of variance
BG	Blood glucose
BMI	Body mass index
CD	Communicable disease
CI	Confidence interval
CVD	Cardiovascular disease
DBP	Diastolic blood pressure
GPAQ	Global Physical Activity Questionnaire
HCMC	Ho Chi Minh City
ICC	Intraclass correlation coefficient
IPAQ	International Physical Activity Questionnaire
IQR	Inter-quartile range
MET	Metabolic Equivalent Task
MRI	Menzies Research Institute
NCD	Non-communicable disease
OR	Odd ratio
PAR	Physical activity record
PR	Prevalence ratio
SBP	Systolic blood pressure
SD	Standard deviation
STEPS	STEPwise approach to surveillance of non-communicable diseases
TC	Total cholesterol
US	The United States
WHO	The World Health Organisation
WHR	Waist to hip ratio

Publications

Publications directly arising from the work described in this thesis

Pham HL, **Au BT**, Blizzard L, Truong BN, Schmidt MD, Granger RH, Dwyer T. Prevalence of risk factors for non-communicable diseases in the Mekong Delta, Vietnam: results from a STEPS survey. *BMC Public Health*. 2009 12 Aug;9(1):291.

Au BT, Blizzard L, Schmidt MD, Pham HL, Magnussen CG, Dwyer T. Reliability and validity of the Global Physical Activity Questionnaire in Vietnam. *J Phys Act Health*. 2010; 7: 410-418.

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Au BT, Blizzard L, Schmidt MD, Pham HL, Granger RH, Dwyer T. The association between smoking and hypertension in a population-based sample of Vietnamese men. *J Hypertens*. 2010 Feb;28(2):245-50.

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Au BT, Blizzard L, Schmidt MD, Pham HL, Magnussen CG, Dwyer T. Reliability and validity of physical activity estimates using the WHO STEPwise instrument in southern Vietnam. Population Health Congress. Brisbane Jul 2008. Oral Presentation.

Au BT, Blizzard L, Schmidt MD, Hansen E, Magnussen CG, Dwyer T. Using pedometer to measure ambulatory physical activity in the Vietnamese population. Australasian Epidemiological Association (AEA) Annual Meeting and International Epidemiological Association (IEA) Meeting. Hobart Sep 2007. Oral presentation.

Au BT, Blizzard L, Schmidt MD, Hansen E, Magnussen CG, Dwyer T. Using pedometer to measure ambulatory physical activity in the Vietnamese population. Sharing Excellence in Research Conference. University of Tasmania, Hobart Sep 2007. Oral presentation.

Au BT, Blizzard L, Schmidt MD, Pham HL, Granger RH, Dwyer T. The association between smoking and hypertension in a population-based sample of Vietnamese men. Inter-American Society of Hypertension XVIIIth Scientific Sessions. Belo Horizonte Aug 2009. Oral Presentation.

Au BT, Blizzard L, Schmidt MD, Pham HL, Granger RH, Dwyer T. The association between smoking and hypertension in a population-based sample of Vietnamese men. Australasian Epidemiological Association (AEA) Annual Meeting. Dunedin, New Zealand, Sep 2009. Oral presentation.

Au BT, Blizzard L, Schmidt MD, Pham HL, Granger RH, Dwyer T. The association between smoking and hypertension in a population-based sample of Vietnamese men. Sharing Excellence in Research Conference. University of Tasmania, Hobart Sep 2009. Oral presentation.

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International Travel Award from the Inter-American Society of Hypertension to attend the Inter-American Society of Hypertension XVIIIth Scientific Sessions in Belo Horizonte, Brazil, Aug 2009.

Student Bursary from the Australasian Epidemiological Association (AEA) to attend the Population Health Congress in Brisbane, Jul 2008.

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Other publications

Callisaya ML, **Au BT**, Blizzard L, Schmidt MD, McGinley JL, Velandai KS. Subject-matter considerations in assessing the fit of a linear regression model. *Australasian Epidemiologist* 2007; 14.2:35-37.

Schirmer JM., **Au BT**. The mind-body connection: patients with somatic complaints with no organic cause. In: Schirmer JM, Montegut AJ. *Behavioural Medicine in Primary Care: A Global Perspective.* Oxford, UK: Radcliffe Publishers. 2009. pp. 29-40.

Chapter 1: Introduction

1.1 Background

Non-communicable disease in Vietnam: an emerging epidemic for an unprepared health system

Since the implementation of the economic reform known as Doi Moi (change and newness) in the mid-1980s, Vietnam has made substantial progress in decreasing poverty, increasing income, and improving living standards of the population (1). Accompanying this development, the health of the population has undergone dramatic change. This change can be summarised as a decrease in the communicable disease (CD) mortality rate, and an increase in the non-communicable disease (NCD) mortality rate (2). Data from the Ministry of Health of Vietnam have shown that the contribution of NCD to total morbidity and mortality rose steadily from 1986 to 2003 (see Figure 1.1 and 1.2) (3), and now outweighs that of CD (4).

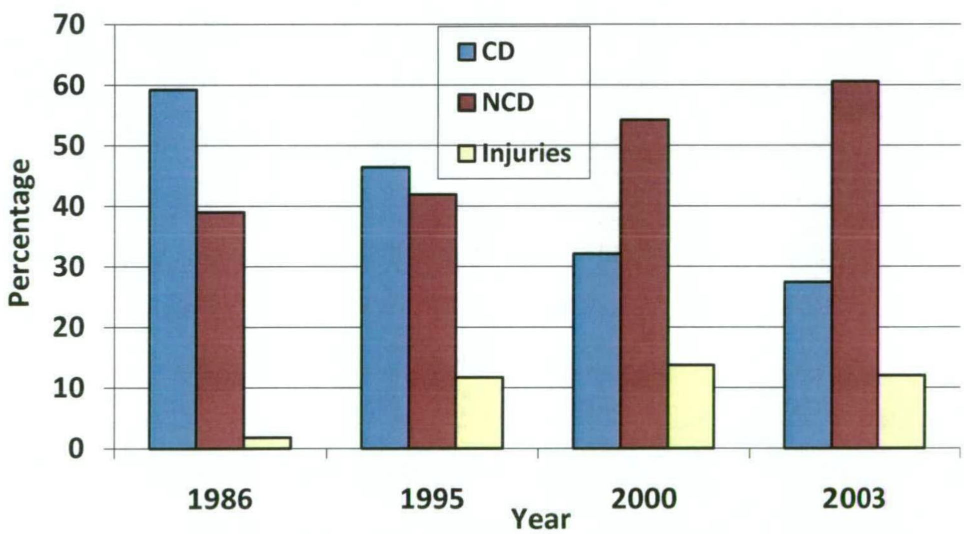


Figure 1.1: Causes of death in Vietnam from 1986 to 2003

CD communicable disease, NCD non-communicable disease

Source: Morbidity and mortality patterns. Ministry of Health. 2009

www.moh.gov.vn

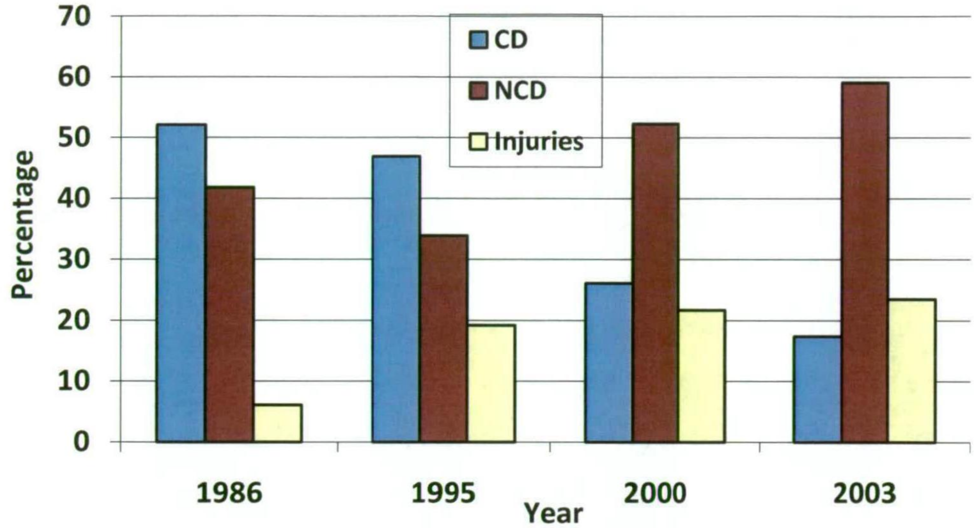


Figure 1.2: Contributors to morbidity in Vietnam from 1986 to 2003
CD communicable disease, NCD non-communicable disease
Source: Morbidity and mortality patterns. Ministry of Health. 2009
www.moh.gov.vn

Furthermore, the proportional rise in NCD mortality may not be due simply to the decrease in CD mortality. Although there are no data for the Vietnamese population, it has been shown that people in other developing countries die from NCD at a much younger age than their counterparts in developed nations (5). In 1990, 46.7% of deaths due to cardiovascular diseases (CVD) in developing countries occurred before 70 years of age in contrast to 22.8% of that in developed countries (6). In Vietnam, together with the to-be-eliminated CD, these premature NCD-related deaths impose a "double disease burden" on the health care system of the country.

Nevertheless, controlling CD is still the highest priority of the Vietnamese health system (2). The limited resources of the country has long been devoted to infection control (2), with little spared for combating NCD. Among the 10 national health programs approved by the Prime Minister in December 2001, eight were infection control and malnutrition programs, another dealt with food quality and hygiene, and the other program was on community mental health (7). Monitoring NCD risk factors at the population level is still in its infancy. The Vietnamese health information system relies mainly on hospital records of diseases and deaths, with little attention paid to risk factors for NCD (8). Surveys of national scales including the Vietnam Living Standard Surveys (9) and the National Nutrition Surveys (10) focus heavily on CD risk factors, poverty, birth control, food security and food hygiene. Studies that address NCD are still ad hoc in nature and conducted in selected regions or population sub-groups (11-15).

Targeting NCD risk factors in Vietnam

To reduce the burden of NCD, public health authorities should aim at reducing NCD risk factor prevalence for the following reasons. Firstly, interventions to reduce prevalence of risk factors have been shown to be the most cost-effective approach in reducing disease burden in general (16), and in reducing the NCD burden in particular (17, 18). Moreover, in developing countries where NCDs affect younger individuals, modifying their risk factors helps prevent the disease and thereby reduces the impact of NCD on healthy life years lost and the productivity of the population (17). More importantly, for a country in the early stage of transition, interventions to prevent the population from adopting unhealthy lifestyles associated with industrialisation and modernisation are crucial (18). Economic development need not be associated with negative health consequences (16). Developing countries do not have to go through the same rise in premature NCD-related deaths experienced by developed nations if appropriate measures are put in place (19).

Population surveys and ongoing surveillance of NCD risk factors play a key role in assessing the risk profile of the population, monitoring changes and evaluating interventions (20). To facilitate these, it is critical to have reliable and valid survey instruments. Whilst biological factors such as body composition, blood pressure, and blood chemistry indices can be measured using standard diagnostic tests developed in Western countries, behavioural risk factors are more culturally specific and can only be accurately measured by instruments that have been locally validated.

Vietnam has some advantages in dealing with the epidemic of NCD after it has already occurred in more developed nations. An enormous body of knowledge has been gained from research undertaken in those countries as or after they went through the epidemic. However, there are cultural reasons that may make some of the established knowledge not applicable to the Vietnamese population. The current NCD prevention guidelines and instruments are derived from research in populations of developed countries. Their applicability in the population of Vietnam needs to be assessed before widespread use is made.

The WHO STEPwise approach

With the increasing burden of NCD worldwide, the World Health Organisation (WHO) is committed to control the epidemics as quickly as possible where they are already present and to prevent them from establishing where they have not established (21). To accomplish this goal it is important to have comparable data from different countries and regions. Therefore, the WHO has developed "The STEPwise approach to surveillance of non-communicable diseases" (STEPS) for use by member countries. The approach is based on two key premises: collection of standardised data on NCD risk factors, and sufficient flexibility for use in a variety of country situations and settings. The STEPS instrument is accompanied by standardised protocols for each measurement. Step 1 involves obtaining questionnaire-based data on those risk factors that have a major impact on health and are most amenable to intervention. It includes socio-economic and demographic variables, tobacco and alcohol use, physical inactivity and fruit and vegetable consumption as core items. Step 2 involves physical measures with height, weight, waist circumference and blood pressure as core items. Step 3 involves biochemical measures with blood glucose (BG) and total cholesterol (TC) as core items. Once the Step 1 core items are in place, and as resources permit, countries can add core data items from Steps 2 and/or 3 and optional data items at any step to suit local needs.

Why monitor population levels of physical activity?

Physical activity is one of the four key behavioural risk factors for NCD that have been selected for surveillance by WHO. The four are smoking, alcohol use, fruit and vegetable consumption, and physical activity (20). These were selected because (1) there is substantial evidence of their associations with NCD; (2) they are modifiable; and (3) their measurements can be performed within ethical standards (22). Whilst establishing locally valid measurement tools for all the four risk factors is beyond the scope of this thesis, evaluating the applicability of the current international physical activity measurements in the Vietnamese population can add significant knowledge in respect of NCD risk factor surveillance in Vietnam and other countries with similar characteristics.

Monitoring of physical activity participation levels of the Vietnamese population is of particular importance because, although not documented, the physical activity level of the population is likely to have decreased significantly in the last few decades and is expected to keep decreasing as industrialisation occurs. This has been the case in neighbouring China (23, 24). If there has been a decline in physical activity in Vietnam, the possible contributors to this change are as follows. Firstly, from the absolute dependence on human and animal physical efforts in the past, farming practice in Vietnam nowadays is supported by an increasing use of machinery. To illustrate, the number of pieces of major equipment possessed by each farming unit increased more than fourfold from 2001 to 2006 (25). Moreover, motorbikes and motored boats are now common means of transport and reflect enhanced social status, leaving self-powered commuting as an activity of the poor. The number of households with at least one motorbike increased from 25.9% in 2001 to 52.6% in 2006 (25). Moreover, sports and leisure physical activity are still uncommon (26) whilst the number of households owning a television increased from 38.4% in 2001 to 78.1% in 2006 (25). In short, these factors may have collectively contributed to the likely decline in physical activity of the Vietnamese population. To document their effects, and to keep public health authorities informed as activity patterns continue to change profoundly whilst the country moves to more advanced stages of industrialisation, regular surveillance of physical activity of the population is therefore critical.

Issues in measuring physical activity by questionnaires

Physical activity has long been identified as an important determinant of health (27), yet measuring it accurately remains a challenge (28, 29). In population surveys, physical activity is typically measured by self-report questionnaires, which are low cost and relatively easy to administer and thus remain an important tool for large-scale fieldwork (30). Nevertheless, questionnaires are subject to a number of limitations. Firstly, because of the limitation of human memory, questionnaires are prone to random and systemic errors of recall (29). Moreover, because activities are undertaken at varying intensity, information is generally sought on intensity when physical activity is measured by questionnaires. The problem is that people have different perceptions about intensity, and tend to report the peak intensity of an activity (29). In addition, questionnaires often do not take into account activities that last less than a certain period of time (10 minutes, for example), and require less than a certain level of effort (brisk walking, for example) because self-report of low intensity activities, especially those that are unstructured, are prone to underestimation. This results in light intensity activities being under-estimated. This phenomenon is called the floor effect (29). Overall, while questionnaires can be useful in monitoring changes in population activity (31), they should be used with caution when the purpose is detailed interpretations in terms of dose-response and health benefits (29).

Particular issues in measuring physical activity in Vietnam

Physical activity in Vietnam reflects the daily activities of a population in a developing country. Firstly, whilst populations from industrialised areas may have a sedentary lifestyle, rural residents are often involved in occupations that require physical effort. Secondly, with the exception of office workers, the population may not have a clear weekday and weekend pattern of activity. The measurement of physical activity in rural areas is especially challenging because work patterns tend to change according to the progress of crops and season. As a result, a large segment of the population may be unemployed at certain times of the year or be employed in jobs with highly variable activity requirements. These factors may make it difficult to accurately measure habitual physical activity patterns of the Vietnamese population using currently available instruments, which have been largely designed and validated for use in Western populations.

The Global Physical Activity Questionnaire (GPAQ)

The Global Physical Activity Questionnaire (GPAQ) is one component of the STEPS questionnaire (32). It was developed by WHO in February 2002 after a review of existing questionnaires, particularly the International Physical Activity Questionnaire (IPAQ) for their usefulness in developing country settings. GPAQ was designed as a modification of IPAQ. The level of detail of GPAQ is a "compromise" between the long and short forms of IPAQ.

GPAQ is a 14-item physical activity questionnaire designed to measure three domains of physical activity: work (paid and unpaid, inside and outside of home), transport, and recreation or leisure. The questions focus on moderate and vigorous activity of at least 10 minutes duration in a typical week for each domain (32). Information is also sought on time spent in a sedentary state. The questionnaire takes about 16 minutes to complete by face-to-face interview.

GPAQ has been recommended for use in developing countries as part of STEPS surveys. However, its reliability and validity in measuring physical activity in these populations is not well documented. In Vietnam, GPAQ has been shown to have reasonable reliability (test re-test correlations 0.55 to 0.69) and modest validity (correlations with accelerometer estimates 0.20 to 0.34) when measuring physical activity in the urban population of Ho Chi Minh City (HCMC) (33). Physical activity patterns of residents of this biggest commercial centre of Vietnam are unlikely to represent those of rural dwellers. Whilst GPAQ provides an important vehicle for public health authorities in surveillance of physical activity participation at the population level, and it should be further validated before put to widespread use in the Vietnamese population.

Other instruments and measurement approaches for population surveillance of physical activity

The International Physical Activity Questionnaires (IPAQ)

IPAQ was the first international effort in developing a questionnaire that can obtain comparable data in cross-country settings. It was designed to measure physical activity among 18–65 year olds (34). There are two different versions of IPAQ. The short version (IPAQ-S) is a nine-item questionnaire designed for use in surveillances. The long version (IPAQ-L) has 27 items and provides more detailed information for research work or evaluation purposes (34). IPAQ-L reports physical activity in four domains of household and yard-work activities, occupational activity, self-powered transport, and leisure time physical activity. Information is sought on time spent walking and in moderate-intensity and vigorous-intensity activity within each domain. It has additional questions on sedentary activity. The reference period is "the last seven days".

Physical Activity Record (PAR)

Another self-report method that is less commonly used is the physical activity record (PAR), also called physical activity calendar, diary or log. In some studies, participants were required to give a short description of their activities and to report the time spent on each activity and the intensity with which each was performed (35, 36). In other studies, participants were asked to tick activities from a list, and provide the corresponding duration of time (37). The data can be expressed as minutes spent in certain intensity categories, or as energy expenditure by multiplying the time spent by a Metabolic Equivalent Task (MET) value. A MET scale provides values to weight the activities by their intensities relative to the basic metabolic rate (the minimum rate of energy expenditure that is needed to support vital functions such as breathing and digesting food).

In free-living populations, the PAR assists with recall but it is still subjective and error prone (for example, a participant may misclassify the intensity of his or her activity) (36). In addition, the use of PAR also requires intensive effort, cooperation and motivation from study participants. To date the PAR has only been used by a limited number of studies (35-38), and mainly as the comparison for another method.

Direct monitoring of physical activity

The main alternative method for self-report measures is direct monitoring of physical activity. This includes behavioural observations and physical measurements. Behavioural observation involves an observer watching and recording physical activity of study participants. This approach eliminates errors of recall by study participants but is subject to errors of observation and recording by observers, and its use is limited by cost and observer-burden and therefore is not suitable for large-scale population surveys (27).

Physical measurements include monitoring of energy expenditure, and motion sensors to detect body movements (39). Physical monitoring of energy expenditure includes direct or indirect calorimetry and doubly-labelled water. Both methods are expensive and impractical for use in large-scale studies (40). Motion sensors are mechanical and electronic devices that detect motions or accelerations of a limb or a trunk (41). A wide range of mechanical and electronic devices has been developed to detect physical motions, including accelerometers and pedometers.

Accelerometers include uniaxial accelerometers and triaxial accelerometers. Uniaxial accelerometers capture acceleration in the vertical direction. Triaxial accelerometers measure accelerations in the vertical, and mediolateral planes. Both types of accelerometers have large memory capacity and can record not only the total amount of activity but also the duration, intensity, and frequency (40). The data obtained from accelerometers required special computer software to process (40).

Pedometers, also called step counters, are small devices worn on the waist at the midline of the thigh. They count body movements in the vertical direction and store as "steps". Many models of pedometers also allow the calculation of distance walked and energy spent if step length, body weight and height are entered (42). Pedometers have been tested intensively and they appear to be relatively good for measuring physical activity at the population level (43, 44).

In terms of activity types, both accelerometers and pedometers are very good as measuring activities such as walking and running (42, 45). However, they tend to under-predict the energy cost by other activities because of the inability to detect upper body movements (46). In addition, to a lesser extent, they can erroneously register non-steps movements (for example, when the subject travels in a motor vehicle (47)).

Because measurements by motions sensors are made objectively without human input, they help avoid human errors in reporting, translating, and interpreting physical activity (48). Compared to accelerometers, pedometers are much lower in cost, relatively easy to use, the data obtained from them are easy to process, and their estimates of physical activity are highly correlated with those of accelerometers (44, 47, 49). For these reasons, pedometers are more suitable than accelerometer for large-scale population surveys and are increasingly used (50, 51).

Previous studies of physical activity in Vietnam

Several previous studies (11, 12, 14) of NCD risk factors in Vietnam did not attempt to measure physical activity. To date, there have been only two studies that have included measurement of physical activity. Both used questionnaires and were conducted in the population of Ho Chi Minh City (HCMC). The instrument used in the first study (13) was based on a questionnaire used for Pima Indians (52). The second study (26) utilised the GPAQ and assessed its validity in the population of HCMC (53). The physical activity participation patterns of people who live in this biggest commercial centre of Vietnam is unlikely to be similar to those of rural dwellers, who constitute more than 70% of the Vietnamese population (54). There have been no studies designed to validate the GPAQ in the rural population of Vietnam, and to explore the use of pedometers for estimating physical activity in the Vietnamese population.

1.2 Research aims and objectives

General aim

The general aim of the investigation reported in this thesis was to evaluate the reliability and validity of several methods of measuring physical activity in the Vietnamese population

Specific objectives

The specific objectives of this investigation were:

1. To provide information on the NCD risk profile of the Vietnamese population living in the Mekong Delta, Vietnam;
2. To assess and compare the reliability and validity of GPAQ and IPAQ in estimating physical activity of people in the Mekong Delta;
3. To assess the feasibility, stability and validity of pedometer measurements of physical activity in Vietnam;
4. To provide insights on practical issues involved in the use of pedometers and the PAR to estimate physical activity in the Vietnamese population;
5. To examine the patterns of physical activity and the association of both total and domain-specific physical activity with CVD risk indicators in a population-based Vietnamese sample.

1.3 Thesis outline

In brief, the structure of the thesis can be described as follows:

Chapter 1: Introduction.

This chapter provides the context for the investigation reported in this thesis. It gives a brief overview of physical activity measurements at the population level, and describes the aims and the structure of the thesis.

Chapter 2: Prevalence of risk factors of NCD in the Mekong Delta, Vietnam: results from a STEPS survey.

This chapter presents the results of a population-based survey of a sample (n=1978) of 25-64 year-old residents of Can Tho in the Mekong Delta, Vietnam. Other than the additional analyses in Appendix 2A, the contents of this chapter have been published in a peer-reviewed journal (55).

Chapter 3: Reliability and validity of the Global Physical Activity Questionnaire in Vietnam.

This chapter compares the reliability and validity of GPAQ and IPAQ made in a sub-sample (n=251) of the participants in the population survey. Other than the additional analyses in Appendix 3A, the contents of this chapter have been published in a peer-reviewed journal (56).

Chapter 4: Using pedometer to measure ambulatory physical activity in Vietnam.

This chapter reports on the feasibility, stability and validity of pedometer estimates of ambulatory physical activity. The study reported was conducted in the sub-sample (n=251) of the population survey participants. Other than the additional analyses in Appendix 4A, the contents of this chapter have been published in a peer-reviewed journal (57).

Chapter 5: Issues to consider when using pedometers to measure physical activity in Vietnam: a qualitative approach.

This chapter describes the qualitative findings on practical issues that need to be considered when using pedometers in Vietnam. The informants were a sample of study participants (n=26) selected by maximum variation techniques and all health volunteers (n=15) who were involved in the pedometer study reported in Chapter 4. A brief summary of the results presented in this chapter has been published together with the quantitative findings on pedometer use in Vietnam (57).

Chapter 6: Confounders and effect modifiers of the associations of physical activity and CVD risk indicators.

This chapter investigates whether any of the other behavioural risk factors (tobacco smoking, alcohol intake, fruit and vegetable intake) was a confounder or effect modifier of the association between physical activity and CVD risk indicators. Appendix 6A describes more fully the relationship between smoking and hypertension. The contents of this appendix have been published in a peer-reviewed journal (58).

Chapter 7: Physical activity and its association with CVD risk indicators in Vietnam.

This chapter presents information on participation in leisure and work physical activity, and the associations of both total and domain-specific physical activity with CVD risk indicators in the population survey sample (n=1978). At the time of submission of this thesis, the contents of this chapter were under review by a peer-reviewed journal (59).

Chapter 8: Summary.

This chapter draws together the major findings and conclusions, summarises the collective contribution of the thesis, and presents recommendations for future research.

Chapter 2: Prevalence of risk factors for non-communicable diseases in the Mekong Delta, Vietnam: results from a STEPS survey.

2.1 Preface

In this chapter, the results of a population-based survey of risk factors for non-communicable diseases (NCD) in the population of Can Tho in the Mekong Delta, Vietnam are presented. The survey utilised the "STEPwise approach to surveillance of risk factors for non-communicable diseases" (STEPS) developed by the World Health Organisation (WHO). Included among the measurements are estimates of physical activity made using the Global Physical Activity Questionnaire (GPAQ). In subsequent chapters, I examine the reliability and validity of the measurement of physical activity by GPAQ and investigate the feasibility of alternative methods.

The Can Tho STEPS survey was designed to examine the prevalence of risk factors of NCD in the population of 25-64 year old residents of Can Tho. The study was a collaborative project between Faculty of Public Health, Can Tho University of Medicine and Pharmacy, Vietnam and the Menzies Research Institute (MRI) in Hobart, Australia. Data collection of the survey was funded by The Atlantic Philanthropies, Inc.

Prior to the survey, a group of consultants from MRI provided a training program to prepare local staff for survey planning and implementing. A scientific committee consisted of six local specialists (including public health professionals, one nutritionist, and one internal medicine specialist) and three MRI staff was formed. This committee was responsible for designing the Can Tho STEPS instrument based on the WHO STEPS instrument version 1.4, for planning the survey, and for supervising data collection. The data collection team included one field supervisor, six interview staff and six other field staff who were responsible for undertaking measurements of anthropometry, blood pressure and blood biochemistry.

All equipment was calibrated before use. The automatic blood pressure machine was calibrated with a mercury sphygmomanometer at every new site. Anthropometry measures were tested for inter- and intra-variability. A pilot study was conducted to test the instrument, to identify areas of inadequate planning, and to provide data collection staff an opportunity to improve their skills and to get used to the setting of the clinics.

On average, data collection occurred over for two days at each site,(mostly over weekend days). There was also a day set aside for setting up the survey clinic at each site prior to clinic days. For most sites, the clinic was located at the local health centre. In addition, schools or other buildings were also used. Participants were invited to come to the clinics after an overnight fast. Data collection occurred early in the morning to allow participants to return to their routine activities after attending the clinics.

Photo: Data collection team. *Back step (from left)*: Dr. Bui Van Tan, Dr. Nguyen Thi Thanh Phuong, Ms Luong Thi Anh Thu, Ms. Tran Thi Nga, Dr. Nguyen Thi Thu Cuc, Dr. Le Minh Huu, Ms Tran Thi My, Mr. Tran Van Dien, Dr. Ho Long Hien, Dr. Nguyen Kim Cuong, Ms. Vo Doan Trang. *Front step (from left)*: Ms. Tran Thi Ngoc Phuong, Dr. Au Bich Thuy, Ms. Vo Thi Kim Loan, Dr. Thai Thi Ngoc Thuy, Ms. Duong Thi Loan, Mr. Huynh Van Truong, Mr. Nguyen Van Dau

Double data entry was performed using EPI INFO version 6.04 and EpiData version 3.0 by different operators following the WHO STEPS protocols. Discrepancies were checked with hard copies and were rectified. After the completion of data entry, all alterations to the data were documented.

Findings from this survey have been published in a peer-reviewed journal (55). Additional unpublished analyses are reported in Appendix 2A.

2.2 Background

Despite the increasing burden of NCD in Vietnam (3, 60), information on the prevalence of preventable risk factors for NCD is restricted to the main urban centres of Ha Noi (12, 14, 61, 62), and Ho Chi Minh City (HCMC) (13, 26, 63, 64). Taken together, these studies paint an incomplete picture of the NCD risk factor profile of the Vietnamese people. In particular, there is a critical lack of information for the 80% of the population living outside the industrialised areas in and around Ha Noi in the North and HCMC in the South. With the exception of a study conducted in Bavi (14, 62), a poor district of Ha Noi, little is known about the NCD risk factor profiles of people living in rural areas of Vietnam.

Home to 21 percent of the country's population, the Mekong Delta – literally the "nine dragon river delta" – is the far southern region of Vietnam. The tributaries of the Mekong River act as a transport network and deposit alluvium, increasing the fertility of the soil that produces abundant harvests of rice and other crops (65). The river system is also a significant source of food to the population via the fish it supplies. While the Mekong Delta is the main food production area of the country, health services in this region (assessed as number of hospital beds and number of health personnel per 100,000 people) are below the country average (66). There are no studies apart from our own work that investigate the prevalence of NCD risk factors among residents of the Mekong Delta. Presenting the NCD risk profile for this population would provide the first systemic information of its type to compare with that of other regions and to serve as a baseline for future studies. Moreover, this information will help local authorities to prioritise the health service and health promotion interventions in the region.

This study aimed to describe the prevalence of risk factors for NCD in a rural Vietnamese sample from the Mekong Delta using standardised survey methodology developed by WHO - the STEPS (67). In addition, we compare estimates for men and women in this sample, and our results to those of previous surveys conducted in the two big cities and discuss possible explanations for the differences found.

2.3 Methods

Subjects and sampling

This population-based survey was conducted among 25-64 year old residents of Can Tho in the Mekong Delta, Vietnam. Eligible subjects were selected by multistage sampling with age, sex, and urban/rural stratification. In brief, the sampling process was as follows. At the first stage, a sample of eight urban- and eight rural-classified communes was selected with probability proportional to size and with replacement. The second-stage sampling units were health volunteers who are responsible for providing basic health services for residents living in their local area. The health volunteers maintain and update the lists of these people regularly. Collectively the health volunteers cover all households in each commune. One health volunteer was chosen from each selected commune with probability proportional to size of the population for which they were responsible and with replacement. Health volunteers who were responsible for only a small number of households were combined prior to sampling. At the third stage, persons were selected from the list of each selected health volunteer, with stratification for age (we sought equal numbers in the four age categories 25-34 years, 35-44 years, 45-54 years, and 55-64 years) and sex (we sought equal numbers of men and women). The target number of participants in each commune was 125. People who were institutionalized at the time of data collection were excluded. The sample of eligible subjects consisted of 2683 persons of whom 73.7% (1978/2683) participated in this survey.

Informed consent was obtained from participants. Those who could not sign provided verbal consent. The study was approved by the Ethics Committee of Can Tho University of Medicine and Pharmacy. Data collection was carried out from July to November 2005.

Measurements

Measurements by questionnaire consisted of demographic characteristics, socio-economic factors, and four behavioural risk factors (smoking, alcohol consumption, fruit and vegetable consumption and physical activity). The questionnaire was modified with expanded and optional questions to suit local needs. Extended questions were questions in the STEPS instrument modified by adding locally relevant response options (that described types of work specific to the local area, for example). Optional questions were new questions added to the instrument because they were deemed locally important (in relation to passive smoking, for example). All the modifications were done in accordance with the WHO STEPS manual (67). The questionnaire was translated into Vietnamese and back-translated by independent translators to ensure the appropriate meaning of each item was retained. The original WHO STEPS instrument (version 1.4) is presented in Appendix 2B. An English translation of the Can Tho STEPS instrument is presented in Appendix 2C.

Physical measurements included weight (in bare feet without heavy clothing measured using Seca 767 digital scales), height (in bare feet without headwear measured using a Seca 220 stadiometer), waist circumference (at the narrowest point between the lower costal border and the iliac crest measured using a constant tension tape), hip circumference (at the greatest posterior protuberance of the buttocks measured using a constant tension tape), and blood pressure (at the midpoint of the right arm after participants had rested for at least five minutes measured using an Omron T9P digital automatic blood pressure monitor). Two blood pressure readings were obtained for all participants. A third reading was taken if there was a difference of more than 25mmHg for systolic blood pressure (SBP) or 15mmHg for diastolic blood pressure (DBP) between the first two readings. The mean of all measures was used.

Biochemical measures included fasting total cholesterol (TC) and fasting blood glucose (BG) measured in capillary blood using a Roche Diagnostics Accutrend Glucometer.

Data collection staff were medical doctors, laboratory technicians and medical students. They underwent intensive training and supervision provided by the Menzies Research Institute. A pilot study was conducted to test survey instruments and procedures before actual data collection. Questionnaires were administered by face-to-face interviews. All measurements were performed in accordance with the WHO STEPS protocols (67) at a clinic set up at 16 different field testing sites.

Statistical methods

Data were coded and presented according to WHO guidelines (67). Hours of physical activity of moderate and vigorous intensities were weighted by their Metabolic Equivalent Task (MET) values provided in the WHO guidelines (moderate activity is assigned a MET of 4 and vigorous activity is assigned a MET of 8). Analyses were performed using STATA software version 9.2. Complex survey analysis methods were used to estimate the prevalence of study factors taking into account the sampling design and the sampling weight of each participant. A sampling weight for each participant was calculated as the inverse of the probability of selection of that particular participant. The age structure of the Vietnamese population from the 1999 census (68) was used to estimate the age-standardised prevalence of hypertension. In regression analyses, we investigated whether differences between men and women in change in SBP, BG and TC with age could be explained by differences in the four behavioural risk factors or BMI.

2.4 Results

The response proportions in urban and rural locations for each age group are presented in Appendix 2A. The sample was dominated by persons of Vietnamese ethnicity with Chinese and Khmer in the minority. The majority of participants (particularly women) did not complete secondary school to grade 9, and most were self-employed. The most common occupation (particularly among men) was farming. Selected characteristics of the participants are shown in Table 2.1.

Table 2.2 presents prevalence of behavioural risk factors for men and women. Reflecting cultural practice, the prevalence of smoking and alcohol consumption were much higher in men than in women. Additionally, 80.8% (730/910) of men and 50.6% (526/1066) of women reported being exposed daily to tobacco smoke either from themselves or someone else. The average age at the time of commencement of smoking for men was 21.1 (95%CI: 19.7-20.5) years. The average time spent doing moderate and/or vigorous physical activities was 20.47 (95%CI: 15.96-24.98) hours/week for men and 16.27 (95%CI: 13.73-18.80) hours/week for women. The average time spent in sedentary activity was 3.83 (95%CI: 3.26-4.40) hours/day for men and 3.37 (95%CI: 2.81-3.92) hours/day for women. The prevalence of the behavioural risk factors by age group is presented in Appendix 2A.

Table 2.1: Characteristics of study participants in Can Tho, 2005.

	Men (N=911)		Women (N=1067)		*p*
	%	n	%	n	
Age					
25-34	17.2	157	18.8	201	
35-44	26.9	245	27.4	292	
45-54	29.6	270	28.2	301	
55-64	26.2	239	25.6	273	*0.003*
Ethnicity					
Vietnamese	92.2	839	91.0	970	
Chinese	1.5	14	2.3	24	
Khmer	6.2	56	6.8	72	
Others	0.1	1	0	0	*0.059*
Education completed					
< Primary school	38.0	346	55.6	593	
Primary school	27.5	250	21.1	225	
Secondary school	17.8	162	11.9	127	
High school*	10.9	99	7.2	77	
College/University†	5.8	53	4.1	44	*0.002*
Employment status					
Employed	13.1	119	7.4	79	
Self-employed	62.4	568	50.2	535	
Non-paid/student	0.6	5	0.8	8	
Homemaker	0.8	7	25.5	272	
Retired/unemployed‡	7.0	64	4.7	50	
Unstably employed§	16.2	147	11.4	122	*<0.001*
Occupation					
Farmers	35.9	362	24.1	294	
Industrial workers	9.4	73	2.6	16	
Clerks	9.6	66	7.2	58	
Traders	13.8	107	23.7	227	
Homemakers	0.0	0	22.4	257	
Others	31.3	302	20.0	214	*<0.001*

* High school or equivalent (technical school).
† College or university degree or higher.
‡ Including 12 men and 6 women who were disabled.
§ People who did physical work and got paid on a daily basis.
There were one man and one woman who provided only information on age and sex.

The results of pathophysiological measurements are presented in Table 2.3. The mean BMI was 21.2 (95%CI: 20.6-21.9) kg/m^2 for men and 21.5 (95%CI: 21.2-21.8) kg/m^2 for women. The proportions of excess body weight (BMI ≥ 25 kg/m^2) for male and female participants in this sample were 11.1%, and 14.1%, respectively. Using

Table 2.2: Prevalence of behavioural risk factors for NCD* in Can Tho, 2005.

	Men (N=910)		Women (N=1066)	
	% ±SE†	n	% ±SE†	n
Smoking				
Current smoker	67.8 ± 1.8	631	1.1 ± 0.5	16
Daily smoker	63.1 ± 2.2	594	0.6 ± 0.3	10
Non-daily smoker	4.6 ± 0.9	37	0.4 ± 0.2	6
Ex-smoker	13.0 ± 1.1	130	0.1 ± 0.1	3
Never smoker	19.2 ± 1.6	149	98.8 ± 0.6	1047
Alcohol consumption				
Ever consume alcohol	87.2 ± 1.7	794	11.6 ± 1.0	127
Consume last 12 months‡	80.9 ± 1.9	718	9.3 ± 0.8	104
Consume weekly	39.9 ± 1.8	345	0.8 ± 0.5	12
Consume 5 days last week§	6.6 ± 1.3	84	0.4 ± 0.2	6
≥ 5 drinks any day‖	38.6 ± 2.7	330	0.4 ± 0.2	7
Fruit & vegetables				
5+ servings/day	30.2 ± 2.1	243	26.5 ± 3.0	238
Physical activity¶				
Low (<600 MET-mins)	32.7 ± 5.3	281	40.4 ± 2.4	405
Moderate (600-2999 MET-mins)	16.7 ± 2.2	171	24.2 ± 1.4	247
High (3000+ MET-mins)	50.6 ± 5.3	452	35.4 ± 3.1	396

* Non-communicable diseases.
† Standard errors.
‡ Consume alcohol in the last 12 months.
§ Consume alcohol on at least 5 days in the past 7 days.
‖ Consume 5 drinks or more on any single day in the last 7 days.
¶ Moderate and/or vigorous activity in a typical week.

the WHO recommended cut point for Asian populations, 23.6 (95% CI: 15.4-31.8) % of men and 31.8 (95%CI: 28.7-34.9) % of women in this sample were overweight or obese (BMI ≥ 23 kg/m^2). The mean waist circumference was 75.0 (95%CI: 73.0-77.1) cm for men and 72.2 (95%CI: 71.2-73.3) cm for women. The proportion of abdominal obesity (waist circumference ≥ 90 cm for men or waist circumference ≥ 80 cm for women) was 7.7 (95%CI: 4.4-11.0) % for men, 17.8 (95%CI: 15.3-20.3) % for women, and 12.9 (95%CI: 10.0-15.8) % for both sexes combined. The mean SBP was 128.4 (95%CI: 126.5 – 130.4) mmHg for men and 120.1 (95% CI: 118.3-121.8) mmHg for women. The mean fasting BG was 3.62 (95%CI: 3.44-3.81) mmol/L for men and 3.65 (95%CI: 3.47-3.82) mmol/L for women. The mean fasting TC was 4.44 (95%CI: 4.30-4.58) mmol/L for men and 4.66 (95%CI: 4.56-4.75) mmol/L for women.

Table 2.3: Prevalence of pathophysiological risk factors for NCD* in Can Tho, 2005.

	Men (N=910)		Women (N=1066)	
	% ±SE†	n	% ±SE†	n
Body mass index				
<18.5 kg/m^2	16.8 ± 2.8	174	17.4 ± 1.9	172
18.5–19.9 kg/m^2	21.8 ± 2.1	201	18.6 ± 1.5	169
20.0–22.9 kg/m^2	37.8 ± 2.4	327	32.2 ± 2.4	354
23.0–24.9 kg/m^2	12.5 ± 2.4	112	17.7 ± 0.9	192
25.0-29.9 kg/m^2	8.8 ± 2.1	83	12.6 ± 1.1	155
30+ kg/m^2	2.3 ± 1.2	10	1.5 ± 0.4	22
Hypertension‡				
Yes	27.3 ±2.5	320	16.2 ±1.5	280
No	72.7 ±2.5	590	83.8 ±1.5	786
Blood glucose				
<6.1 mmol/l	99.0 ±0.6	856	98.9 ±0.2	1014
6.1-7.0 mmo/l	0.6 ±0.5	5	0.3 ±0.1	8
7.0+ mmol/l	0.4 ±0.2	3	0.8 ±0.2	16
Total cholesterol				
<5.2 mmol/l (<200 mg%)	85.5 ±2.4	730	79.1 ±2.1	770
5.2+ mmol/l (200+ mg%)	14.5 ±2.4	136	20.9 ±2.1	268

*Non-communicable diseases.
† Standard errors
‡ Systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg or taking medication for hypertension.

Table 2.4 shows the estimates of pathophysiological risk factors in the four age groups sampled. More strongly for men than for women, mean levels of BMI ($p < 0.001$), and – adjusted for BMI – means levels of BG ($p = 0.137$) and TC ($p < 0.001$) increased with age. Mean levels of SBP adjusted for BMI also increased more strongly ($p = 0.036$) for women than for men, but from a lower level and did not overtake mean SBP of men even among 55-64 year olds. Adjusted also for the behavioural risk factors (smoking, alcohol, fruit and vegetable consumption and physical activity), the difference in trends remained stronger for women (SBP $p = 0.031$, BG, $p= 0.009$, TC $p = 0.014$).

More men (27.3%) than women (16.2%) were hypertensive (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg, or taking medication for hypertension). Only 29.2 % of hypertensive men, but 56.6% of hypertensive women, were aware of their condition. The prevalence of hypertension increased with age for both men ($p < 0.001$) and women ($p < 0.001$) (Figure 2.1). The age-standardised prevalence of hypertension was 26.7% for men and 15.9% for women.

Table 2.4: NCD[*] risk factor estimates by age group and sex in Can Tho, 2005.

	BMI[†] Mean(SE)	SBP[‡] Mean(SE)	BG[§] Mean(SE)	TC[ǁ] Mean(SE)
Men				
25-34	21.4(0.6)	126.0(1.7)	3.56(0.08)	4.39(0.09)
35-44	21.2(0.2)	125.0(1.2)	3.64(0.09)	4.37(0.06)
45-54	21.3(0.3)	134.3(1.3)	3.75(0.10)	4.57(0.08)
55-64	20.8(0.3)	140.0(1.5)	3.65(0.10)	4.66(0.06)
p for trend[¶]	*p=0.543*	*p<0.001*	*p=0.015*	*p=0.008*
Women				
25-34	20.5(0.2)	114.3(1.0)	3.49(0.10)	4.46(0.08)
35-44	21.4(0.3)	116.5(1.3)	3.61(0.10)	4.45(0.05)
45-54	22.9(0.3)	129.3(1.0)	3.87(0.09)	4.99(0.07)
55-64	22.6(0.3)	136.6(1.8)	3.93(0.12)	5.26(0.10)
p for trend[¶]	*p<0.001*	*p<0.001*	*p<0.001*	*p<0.001*

[*] Non-communicable diseases.
[†] Body mass index.
[‡] Systolic blood pressure.
[§] Blood glucose.
[ǁ] Total cholesterol.
[¶] p for trend adjusted for age.

The associations between BMI and hypertension are presented in Figure 2.2. Hypertension prevalence increased linearly with BMI ($p = 0.020$ for men and $p < 0.001$ for women) after adjustment for age. For each unit of BMI increase, the odds of having hypertension increased by 11% (95%CI: 2-20%) for men and 17% (95%CI: 11-23%) for women. In each BMI category, there was a higher proportion of hypertensive men than women even after adjusting for age.

2.5 Discussion

This is the first population survey using internationally standardised protocols to report the prevalence of risk factors for NCD in the Mekong Delta, Vietnam. Previous surveys on NCD have been conducted in Ha Noi and HCMC. There have been some data reported for the population of Bavi (62), an extremely poor district of Hanoi (69), but the findings from this study are unlikely to represent the risk profile of the population of the Mekong Delta where income is much higher and land holdings are much larger.

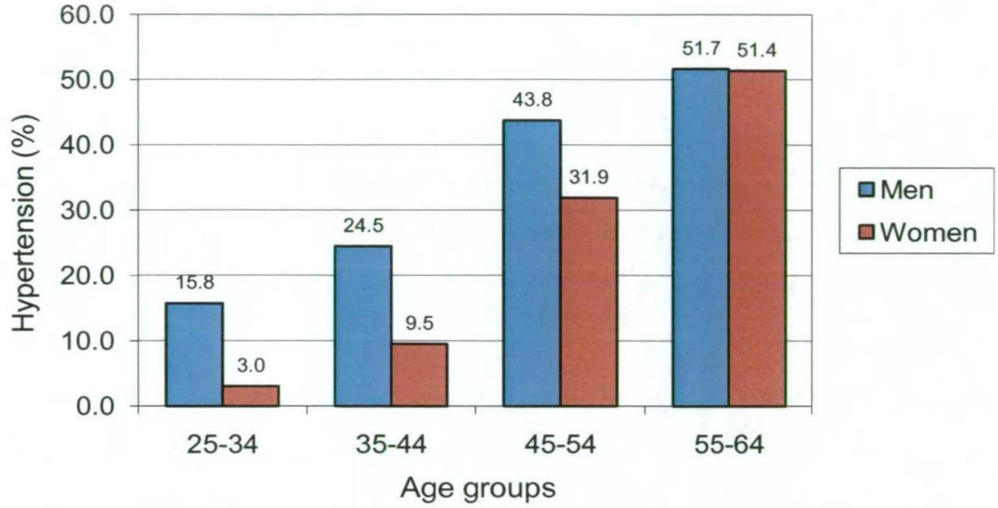


Figure 2.1: Prevalence of hypertension by age group in Can Tho, 2005.

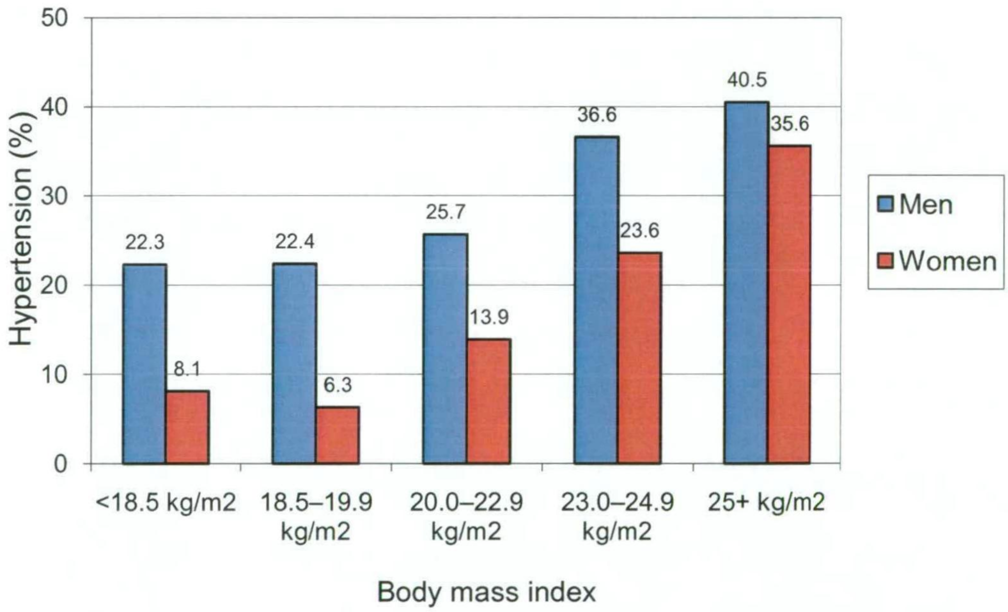


Figure 2.2: Association between body mass index and hypertension in Can Tho, 2005.

The first principal finding of this study was that older women in this population-based representative sample generally had an unfavourable NCD risk profile. The sex differences in SBP and TC persisted after adjustment for BMI. This has not been reported previously for Asian populations, but it mirrors reports for some Western populations that blood pressure and TC of men and women converge with advancing age (70-72). For BG, we found a statistically significant stronger cross-sectional increase with age for women that was diminished by adjustment for BMI but strengthened by additional adjustment for behavioural risk factors. This cross-sectional pattern of increasing levels of BG with age for women, and higher levels for women at older ages, appears not to have been reported previously. Factors not measured in this survey, and which may account for the elevated risk among women, were hormonal status, saturated fat consumption and salt intake.

The second principal finding was the risk profile of this predominantly rural population of Vietnam was markedly different to that reported previously for the two major cities. The prevalence of raised BG (defined as capillary whole BG of at least 6.1mmol/L) in our sample (men: 1.0%, women: 1.1%) are lower than prevalence estimates reported for the big city convenience samples: 2.7% for men and 2.6% for women aged 20-60 in HCMC in 2004 (63), 4.6% of men and 5.8% of women in the subset of participants aged 25-64 in another sample of HCMC population in 2001 (13), and 5.8% of 20-74 years old residents in Ha Noi in 2005 (61). A possible explanation for these differences lies in the higher proportion of overweight and obesity observed in the big city surveys. The proportions of obese (BMI at least 23 kg/m^2) participants in our sample (men 23.6%, women 31.8%) were lower than that reported for the Ha Noi sample (33.7%) (61), fewer participants in our survey (12.9%) than in the Ha Noi sample (17.5%) (61) had abdominal obesity (waist circumference ≥ 90 cm for men or waist circumference ≥ 80 cm for women). In the HCMC sample, 18.6% of participants had BMI at least 25 kg/m^2 but only 12.7% (men 11.1%, women 14.1%) of our participants exceeded this level (13). In the rural sample of Ha Noi from Bavi, only 3.5% of participants had BMI at least 25 kg/m^2 (62). Another possible explanation for the higher prevalence of raised BG in the big city samples is the lower levels of physical activity among the urban residents. There was 46.6% of men and 41.3% of women aged 25-64 in a HCMC sample in 2005 (26) classified as having a low level of physical activity compared to 32.7% of men and 40.4% of women in our samples.

In contrast to raised BG, the proportions of participants in our sample with hypertension (27% of men and 16% of women) exceed the prevalence estimates reported for the big city surveys. Hypertension was identified among 21% of men and 10% of women in a sample of 25-64 year olds from a single commune in Ha Noi in 2007 (12), 17.5% for the subset of 20-59 year old participants of a convenience sample from two districts of Ha Noi in 2005 (61), and 11% for men and 9% for women aged 20-60 in HCMC (63). Our results are more similar to those reported for the extremely poor rural sample of Ha Noi from Bavi (62) in 2005 (24% for men and 14% for women aged 25-64) in which the prevalence of overweight and obesity was less than a third of that found this study. Dietary sodium intake has been linked with hypertension (73), and salt consumption may be higher in poor rural areas where it is used to add flavour to rice. No published study to date has measured dietary sodium levels in a Vietnamese population, however, and this contention remains unsupported. Alcohol has been shown to be associated with elevated blood pressure (74). Our prevalence estimates of alcohol consumption are the only published Vietnamese data, and, therefore, no comparisons are possible. Tobacco smoking has been associated with elevated blood pressure in another study from this region (75). The limited data on smoking prevalence in Vietnam show relatively minor variation through the country. In our sample, 67.8% of men and 1.1% of women were current smokers. In a HCMC sample of 20-60 year olds, 62.2% of men and 1.4% of women were current smokers in 2004 (63) and 62.9% of men and 0.6% of women were current smokers in the Bavi sample (62).

A key strength of this study was its use of a representative sample, with analysis done taking into account the complex survey design. The relatively high response proportion minimises the likelihood of selection bias, and the range and quantum of factors that were measured should be a good reflection of those factors in the Vietnamese population. The use of WHO standardised protocols, intensive training of data collection staff, pre-study testing of procedures, and the close supervision of staff during data collection, all highlight the attention that was paid to minimising avoidable sources of measurement error.

Limitations of this study need to be borne in mind. The STEPS methodology is designed to provide standardised information on key modifiable risk factors that can be measured in population-based surveys without resort to high technology instruments. It is not designed to measure total energy intake, dietary fat, dietary sodium, body fatness, or physical activity by objective methods such as accelerometry and pedometry. Information on these factors would have provided a more comprehensive picture of the relationships we studied. In addition, these cross-sectional data do not allow age-related differences in blood pressure, BG and TC to be attributed to ageing independently of cohort effects.

2.6 Conclusions

This study provides the first NCD risk factor profile of people in the Mekong Delta of southern Vietnam using internationally standardised methodology. Our findings for this predominantly rural sample differ from previous studies conducted in Ha Noi and HCMC, and suggest that it is inappropriate to generalise findings from the big-city surveys to the more than 80% of Vietnamese people who live outside the two commercial centres.

2.7 Postscript

This chapter has presented information on the prevalence of NCD risk factors of the Vietnamese population in the Mekong Delta. This information has provided a risk profile of the local population that, given the characteristics that distinguish it from previously-reported risk factors prevalence in the population of HCMC and Hanoi, will be an important guide in interpreting the findings of subsequent chapters. Included among the measurements reported in this chapter were estimates of physical activity made using the GPAQ instrument. In the next chapter, the reliability and validity of the GPAQ estimates of physical activity in the Vietnamese population will be assessed using a randomly selected subsample (n = 251) of the STEPS survey participants. The test re-test reliability and validity of GPAQ will be compared to those of the International Physical Activity Questionnaire (IPAQ). The validity of GPAQ and IPAQ will be assessed using the correlations of their estimates of physical activity with those of physical activity record (PAR) and pedometers.

Appendix 2A: Additional results from the STEPS survey

2A.1 Introduction

In the Can Tho STEPS survey, eligible subjects were selected by multistage sampling with age, sex, and rural/urban stratification. Age was used at the third stage of the sampling process to select persons from the lists provided by health volunteers. We sought equal numbers of subjects in the four categories of age (25-34, 35-44, 45-54, and 55-64). This section presents the response proportions and the prevalence of behavioural risk factors by age group.

2A.2 Results

Table 2A.1 presents the participation proportions for men and women stratified by age and rural/urban location. Overall, the proportions were higher in rural than in urban areas and among women than among men. Additionally, participation was higher for older persons, and ranged from 61.8% among 25-34 year olds to 79.1% among 55-64 year olds.

Table 2A.1: Percentage of participants in rural and urban areas for each age group in Can Tho, 2005.

	25-34	35-44	45-54	55-64	Total
	% (n/N)*	% (n/N)*	% (n/N)*	% (n/N)*	% (n/N)*
Urban					
Male	51.3 (78/152)	64.2 (124/193)	72.3 (141/195)	78.9 (135/171)	67.2 (478/711)
Female	66.0 (99/150)	73.6 (153/208)	79.3 (161/203)	79.0 (147/186)	75.0 (560/747)
Total	58.6 (177/302)	69.0 (277/401)	75.9 (302/398)	79.0 (282/357)	71.2(1038/1458)
Rural					
Male	58.8 (79/132)	77.6 (121/156)	78.7 (129/164)	76.5 (104/136)	73.6 (433/588)
Female	70.3 (102/145)	81.2 (139/170)	81.9 (140/171)	80.3 (126/157)	78.8 (507/643)
Total	65.3 (181/277)	79.8 (260/326)	79.6 (269/338)	78.5 (230/293)	76.4 (940/1231)
Total					
Male	55.3 (157/284)	62.2 (245/394)	75.2 (270/359)	78.2 (240/307)	70.1 (911/1299)
Female	68.2 (201/295)	77.2 (292/378)	80.5 (301/374)	79.9 (274/343)	76.8(1067/1390)
Total	61.8 (358/579)	73.9 (537/727)	77.9 (571/733)	79.1 (514/650)	73.7(1978/2683)

*n: number of participants; N: number of eligible subjects.

The prevalence of tobacco smoking and alcohol use by age group for men are presented in Table 2A.2. There was no cross-sectional trend in patterns of tobacco use for men across age groups. Using Poisson regression, the prevalence of smoking (p for trend = 0.350) and weekly alcohol use (p for trend = 0.209) were similar across age groups. Data are not presented for women because there were few women who currently smoked cigarettes (1.1%) or consumed alcohol on a weekly basic (0.9%).

Table 2A.2: Tobacco and alcohol use by age group for men in Can Tho, 2005.

	25-34		35-44		45-54		55-64		Total	
	%	n	%	n	%	n	%	n	%	n
Tobacco smoking										
Daily smoker	63.0	103	59.9	154	68.5	181	63.6	156	63.1	594
Non-daily smoker	4.2	5	5.5	11	4.4	13	3.3	8	4.6	37
Ex-smoker	8.0	11	15.6	36	17.2	46	15.6	37	13.0	130
Never smoker	24.7	38	18.9	43	9.8	30	17.5	38	19.2	149
Passive smoker*	79.9	125	81.2	199	82.2	219	78.0	187	80.8	730
Alcohol intake										
Ever consume	85.0	138	89.7	220	88.8	239	82.8	197	87.2	794
Consume <12ms†	82.1	134	84.3	209	78.3	212	68.2	163	80.9	718
Consume weekly	39.9	62	43.5	111	37.4	97	31.1	75	39.9	345
Consume 5 days‡	1.7	4	8.8	26	10.8	30	10.1	24	6.6	84
5+ drinks any day§	42.6	67	38.5	98	35.2	97	28.8	68	38.6	330

* Being exposed to tobacco smoke either of their own or of someone else
† Consume alcohol in the last 12 months
‡ Consume alcohol on at least 5 days last week
§ Consume 5+ drinks on any single day last week

The prevalence of low fruit and vegetable consumption and physical inactivity for men and women by age group are presented in Table 2A.3. Using Poisson regression, the prevalence of low fruit and vegetable intake were higher for older men (p for trend = 0.053) and older women (p for trend = 0.057) than for younger participants. There was no difference in the prevalence of physical inactivity across age groups for men (p for trend = 0.827) and women (p for trend = 0.639).

Table 2A.3: Low fruit and vegetable intake and physical inactivity prevalence by age group and sex in Can Tho, 2005.

	25-34		35-44		45-54		55-64		Total	
	%	n	%	n	%	n	%	n	%	n
Low intake*										
Men	65.0	105	70.3	174	75.6	203	76.2	185	69.8	667
Women	72.6	145	69.6	214	76.0	237	84.2	231	73.5	827
Physical inactivity†										
Men	32.1	45	32.2	70	34.9	90	32.0	76	32.7	281
Women	41.4	83	42.8	110	33.1	94	45.2	118	40.4	405

* Consumed < 5 serving of fruit and vegetable per day.

† Having less than 600 MET-minutes per week of moderate and vigorous physical activity.

Table 2A.4 presents the estimates of fruit and vegetable intake and physical activity for men and women. Using simple linear regression, the estimates of fruit and vegetable intake were cross-sectionally lower for older men ($p = 0.004$) and older women ($p<0.001$). Similarly, older men also had lower estimates of MET-minutes per week of moderate and vigorous activity than younger men ($p < 0.001$). The corresponding trend for women was not significant ($p = 0.432$).

Table 2A.4: Fruit and vegetable intake and physical activity estimates by age group and sex in Can Tho, 2005.

	25-34	35-44	45-54	55-64	Total
	Mean(SE)*	Mean(SE)*	Mean(SE)*	Mean(SE)*	Mean(SE)*
Fruit &veg. intake†					
Men	4.31(0.33)	4.02(0.20)	3.61(0.14)	3.68(0.15)	4.02(0.14)
Women	3.86(0.21)	3.97(0.16)	3.59(0.17)	3.35(0.19)	3.79(0.14)
Physical activity‡					
Men	1004(156)	934(112)	782(73)	642(79)	907(102)
Women	667(98)	570(66)	669(76)	451(58)	616(45)

* Standard error.

† Fruit and vegetable intake in serving per day.

‡ MET-minutes per day of moderate and vigorous physical activity.

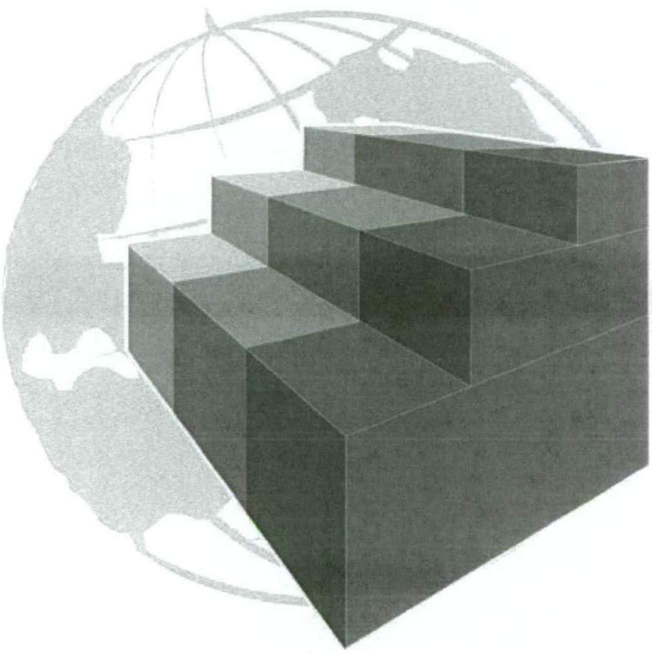
2A.3 Discussion

These findings show that whilst there were no significant differences in the prevalence of tobacco and alcohol use across age groups for men, the levels of physical activity and the amount of fruit and vegetables consumed by participants appeared to vary with age. The lower intake of fruit and vegetables by older men and older women underscores the need for age specific interventions.

Appendix 2B: The WHO STEPS instrument version 1.4

WHO/NMH/CCS/03.03
Version 1.4
DISTRIBUTION: LIMITED

STEPS Instrument
for NCD Risk Factors
(Core and Expanded Version 1.4)



The WHO STEPwise approach to Surveillance of noncommunicable diseases (STEPS)

Noncommunicable Diseases and Mental Health
World Health Organization
20 Avenue Appia, 1211 Geneva 27, Switzerland
For further information: ncd_surveillance.who.int

STEPS Instrument (V1.4)

- This is the generic template which countries use to develop their own Instrument. It contains the CORE (unshaded and in double lined boxes) and EXPANDED items (shaded and in single lined boxes) and response options for Step 1, Step 2 and Step 3.
- The introductory statements, questions and response options should be translated and adapted where necessary to suit local conditions. *Italic typeface indicates where local examples should be inserted.*
- All CORE items should be included in the country-specific STEPS Instrument. Wording and response options for CORE questions should not be changed.
- Some countries may wish to expand the CORE questions. Recommendations for EXPANDED questions for the key risk factors are included in the shaded areas. These items may be modified but it is preferable to use them where possible.
- Additional questions can be added as OPTIONAL items to meet local needs. For example questions asked in previous surveys could be added to link to previous data.
- The use of the coding column (as is used in this Instrument) facilitates easy, fast and accurate manual data entry. Using this approach does not replace the need for double data entry for maximum quality control (see data coding manual).
- Relevant skip patterns are shown on the right hand side of the coding column. They should be carefully reviewed. Modifications to the skip patterns will be needed according to the final items included.

EXAMPLE- for a current smoker who eats 8 servings of fruit on a typical day

		Response	Coding column	Skip
S 1a	Do you currently smoke any **tobacco products**, such as cigarettes, cigars or pipes?	Yes 1 No 2 Don't know 7	1	*If No, go to Next Section*
D 1b	How many **servings** of fruit do you eat on one of those days? USE SHOWCARD	Number of servings Don't know 77	0 8	

- "Do not know", "Don't remember", "Not applicable", "Refuse" are all response options but should be used only as a last resort. In such cases, the first two categories and the last two categories are coded as "7", "77" or "777" and as "8", "88", or "888", respectively depending on the number of numerals in the other response options. Missing responses should be entered as "9", "99" or "999" at time of data entry.
- Interviewer training is essential to develop thorough knowledge of the instrument format, introductory statements, questions, skip patterns, response options, use of show cards and prompts (where needed). The STEPS Field Manual is a guide and resource for training sessions.
- Undertaking pilot work with the draft country-specific STEPS instrument is essential.
- Each country will need to prepare a list of the question numbers (e.g. D1a) and response code cross-referenced with the standard numbers and codes used in this generic template. This cross-referencing will facilitate communication and comparison.

This document is available electronically on the NCD Surveillance website:
http://www.who.int/ncd_surveillance
Other documents cross-referenced in above are available by contacting *ncd_surveillance@who.int*

Respondent Identification Number ☐☐ ☐☐ ☐☐

Identification Information:

This is a draft cover page. Each country will adapt this page to suit their local needs. The exact details to be collected in each country–specific STEPS instrument will vary depending on the survey design and implementation procedures. However, regardless of how the interview is administered (e.g., household, clinic or other) a process by which the cover page containing personal identifying information is stored should be carefully designed and must meet recommended ethical standards. Clear instructions on handling and storage of the cover sheets must be provided to the interviewers.

I 1	Country/district code	☐☐
I 2	Centre (Village name):	☐☐☐☐☐☐☐☐
I 3	Centre (Village code): (SEE NOTE BELOW)	☐☐☐
I 4	Interviewer code	☐☐☐
I 5	Date of completion of the questionnaire	☐☐/☐☐/☐☐☐☐ Day Month Year

---

		Respondent Id Number ☐☐☐☐☐☐		
	Consent			
I 6	Consent has been read out to respondent	Yes 1 No 2	☐	**If NO, read consent**
I 7	Consent has been obtained (verbal or written)	Yes 1 No 2	☐	**If NO, END**
I 8	Interview Language [*Insert Language*]	English 1 [Add others] 2	☐	
I 9	Time of interview (24 hour clock)	☐☐:☐☐		
I 10	Family Name			
I 11	First Name			

Additional Information that may be helpful

I 12	Contact phone number where possible		
I 13	Specify whose phone	Work 1 Home 2 Neighbour 3 Other (specify) 4	☐

Note: Identification information I6 to I13 should be stored separately from the questionnaire because it contains confidential information. Please note: village code (or household code) is required as part of main instrument for data analyses.
Date of interview is required to calculate age.

Respondent Identification Number ☐☐ ☐☐ ☐☐

Step 1 Core Demographic Information

			Coding Column
C1	Sex (*Record Male / Female as observed*)	Male 1 Female 2	☐
C2	What is your date of birth? *If Don't Know, See Note* below and Go to C3*	Day ☐☐ Month ☐☐ Year ☐☐☐☐	
C3	How old are you?	Years	☐☐
C4	In total, how many years have you spent at school or in full-time study (excluding pre-school)?	Years	☐☐

EXPANDED: Demographic Information			
C5	What is your [*insert relevant ethnic group / racial group / cultural subgroup / others*] background?	*[Defined according to local demographic needs]*	☐☐
C6	What is the highest level of education you have completed? *[INSERT COUNTRY-SPECIFIC CATEGORIES]*	No formal schooling 01 Less than primary school 02 Primary school completed 03 Secondary school completed 04 High school completed 05 College/University completed 06 Post graduate degree 07	☐☐
C7	Which of the following best describes your main work status over the last 12 months? *[INSERT COUNTRY-SPECIFIC CATEGORIES]* USE SHOWCARD	Government employee 01 Non-government employee 02 Self-employed 03 Non-paid 04 Student 05 Homemaker 06 Retired 07 Unemployed (able to work) 08 Unemployed (unable to work) 09	☐☐
C8	How many people older than 18 years, including yourself, live in your household?	Number of people	☐☐
C9	Taking **the past year**, can you tell me what the average earnings of the household have been?	Per week ☐☐☐☐☐☐ OR per month ☐☐☐☐☐☐ OR per year ☐☐☐☐☐☐☐ *Go to Next Section* Refused 8	☐ *If Refused Go to C10*
C10	If you don't know the amount, can you give an **estimate** of the annual household income if I read some options to you? Is it *[READ OPTIONS]* *[INSERT QUINTILE VALUES]*	≤ Quintile (Q) 1 1 More than Q 1, ≤ Q 2 2 More than Q 2, ≤ Q 3 3 More than Q 3, ≤ Q 4 4 More than Q 4 5 Refused 8	☐

*Note: Coding Rule: Code "Don't Know" 7 (or 77 or 777 as appropriate).

Respondent Identification Number ☐☐ ☐☐ ☐☐

Step 1 Core Behavioural Measures

CORE Tobacco Use (Section S)

Now I am going to ask you some questions about various health behaviours. This includes things like smoking, drinking alcohol, eating fruits and vegetables and physical activity. Let's start with smoking.

		Response	Coding Column	
S 1a	Do you currently smoke any **tobacco products**, such as cigarettes, cigars or pipes?	Yes 1 No 2	☐	*If No, go to Next Section**
S 1b	**If Yes,** Do you currently smoke tobacco products **daily**?	Yes 1 No 2	☐	*If No, go to Next Section**
S 2a	How old were you when you **first started** smoking daily?	Age (years) Don't remember 77	☐☐	*If Known, go to S 3*
S 2b	Do you remember how long ago it was? *(CODE 77 FOR DON'T REMEMBER)*	In Years OR in Months OR in Weeks	Years ☐☐ Months ☐☐ Weeks ☐☐	
S 3	On average, **how many** of the following do you smoke each day? *(RECORD FOR EACH TYPE)* *(CODE 88 FOR NOT APPLICABLE)* ☐☐☐☐☐☐☐☐	Manufactured cigarettes Hand-rolled cigarettes Pipes full of tobacco Cigars, cheroots, cigarillos ← Other (please specify):	☐☐ ☐☐ ☐☐ ☐☐ ☐☐	

EXPANDED: Tobacco Use				
S 4	In the past, did you **ever** smoke **daily**?	Yes 1 No 2	☐	*If No, go to S 6a*
S 5a	**If Yes,** How old were you when you **stopped** smoking **daily**?	Age (years) Don't remember 7 7	☐☐	*If Known, go to S 6a* *If 7 7, go to S 5b*
S 5b	How **long ago** did you stop smoking daily?	Years ago OR Months ago OR Weeks ago	Years ☐☐ Months ☐☐ Weeks ☐☐	
S 6a	Do you **currently use** any **smokeless tobacco** such as [*snuff, chewing tobacco, betel*] ?	Yes 1 No 2	☐	*If No, go to S 8*
S 6b	**If Yes,** Do you **currently use smokeless tobacco** products **daily?**	Yes 1 No 2	☐	*If No, go to S 8*

* Amend skip instructions if EXPANDED or OPTIONAL items are added to the Tobacco section

S 7	On average, how many **times a day** do you use .... *(RECORD FOR EACH TYPE)*	Snuff, by mouth Snuff, by nose Chewing tobacco Betel, quid Other (specify)	
S 8	In the past, did you **ever use** smokeless tobacco such as [*snuff, chewing tobacco, or betel*] **daily**?	Yes 1 No 2	

CORE Alcohol Consumption (Section A)

The next questions ask about the consumption of alcohol.

		Response	Coding Column	
A 1a	Have you **ever consumed** a drink that contains alcohol such as beer, wine, spirit, fermented cider *or [add other local examples]* ? *USE SHOWCARD or SHOW EXAMPLES*	Yes 1 No 2		*If No, Go to Next Section**
A 1b	Have you consumed alcohol within the **past 12 months**?	Yes 1 No 2		*If No, Go to Next Section**
A 2	In the past 12 months, **how frequently** have you had at least one drink? *(READ RESPONSES)* *USE SHOWCARD*	5 or more days a week 1 1-4 days per week 2 1-3 days a month 3 Less than once a month 4		
A 3	When you drink alcohol, **on average**, how many drinks do you have during one day?	Number Don't know 77		
A 4	During each of the **past 7 days**, how many standard drinks of any alcoholic drink did you have each day? *(RECORD FOR EACH DAY* *USE SHOWCARD)*	Monday Tuesday Wednesday Thursday Friday Saturday Sunday		

EXPANDED : Alcohol

A 5	In the past 12 months, what was the **largest number** of drinks you had on a single occasion, counting all types of standard drinks together?	Largest number	
A 6a	<u>For men only:</u> In the past 12 months, on how many days did you have **five or more** standard drinks in a single day?	Number of days	
A 6b	<u>For women only:</u> In the past 12 months, on how many days did you have **four or more** standard drinks in a single day?	Number of days	

* Amend skip instructions if EXPANDED or OPTIONAL items are added to the Alcohol section

CORE Diet (Section D)

The next questions ask about the fruits and vegetables that you usually eat. I have a nutrition card here that shows you some examples of local fruits and vegetables. Each picture represents the size of a serving. As you answer these questions please think of a typical week in the last year.

D 1a	In a typical week, on how many days do you **eat fruit?** *USE SHOWCARD*	Number of days	☐☐	*If Zero days, go to D 2a*
D 1b	How many **servings** of fruit do you eat on **one** of those days? *USE SHOWCARD*	Number of servings	☐☐	
D 2a	In a typical week, on how many days do you **eat vegetables**? *USE SHOWCARD*	Number of days	☐☐	If Zero days, go to Section P
D 2b	How many **servings** of vegetables do you eat on one of those days? *USE SHOWCARD*	Number of servings	☐☐	

EXPANDED: Diet

D 3	What type of **oil or fat is most often** used for meal preparation in your household? *USE SHOWCARD* *SELECT ONLY ONE* ☐☐☐☐☐☐☐☐	Vegetable oil 01 Lard or suet 02 Butter or ghee 03 Margarine 04 ← Other 05 None in particular 06 None used 07 Don't know 77	☐☐

Respondent Identification Number

CORE: Physical Activity (Section P)

Next I am going to ask you about the time you spend doing different types of physical activity. Please answer these questions even if you do not consider yourself to be an active person.
Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid work, household chores, harvesting food, fishing or hunting for food, seeking employment. *[Insert other examples if needed]*

P 1	Does your work involve mostly sitting or standing, with walking for no more than 10 minutes at a time?	Yes 1 No 2	☐	*If Yes, go to P6*
P 2	Does your work involve vigorous activity, like *[heavy lifting, digging or construction work]* for at least 10 minutes at a time? *INSERT EXAMPLES & USE SHOWCARD*	Yes 1 No 2	☐	*If No, go to P4*
P 3a	In a typical week, on how many days do you do vigorous activities as part of your work?	Days a week	☐☐	
P 3b	On a typical day on which you do vigorous activity, how much time do you spend doing such work?	In hours and minutes OR in Minutes only	hrs ☐☐ : mins ☐☐ or minutes ☐☐☐	
P 4	Does your work involve moderate-intensity activity, like brisk walking *[or carrying light loads]* for at least 10 minutes at a time? *INSERT EXAMPLES & USE SHOWCARD*	Yes 1 No 2	☐	*If No, go to P6*
P 5a	In a typical week, on how many days do you do moderate-intensity activities as part of your work?	Days a week	☐☐	
P 5b	On a typical day on which you did moderate-intensity activities, how much time do you spend doing such work?	In hours and minutes OR in Minutes only	hrs ☐☐ : mins ☐☐ or minutes ☐☐☐	
P 6	How long is your typical work day?	Number of hours	hrs ☐☐	

Other than activities that you've already mentioned, I would like to ask you about the way you travel to and from places. For example to work, for shopping, to market, to church. *[insert other examples if needed]*

P 7	Do you walk or use a bicycle (*pedal cycle*) for at least 10 minutes continuously to get to and from places?	Yes 1 No 2	☐	*If No, go to P9*
P 8a	In a typical week, on how many days do you walk or bicycle for at least 10 minutes to get to and from places?	Days a week	☐☐	
P 8b	How much time would you spend walking or bicycling for travel on a typical day?	In hours and minutes OR in Minutes only	hrs ☐☐ : mins ☐☐ or minutes ☐☐☐	

The next questions ask about activities you do in your leisure time. Think about activities you do for recreation, fitness or sports *[insert relevant terms]*. Do not include the physical activities you do at work or for travel mentioned already.

P 9	Does your *[recreation, sport or leisure time]* involve mostly sitting, reclining, or standing, with no physical activity lasting more than 10 minutes at a time?	Yes 1 No 2	☐	*If Yes, go to P 14*
P 10	In your *[leisure time]*, do you do any vigorous activities like *[running or strenuous sports, weight lifting]* for at least 10 minutes at a time? *INSERT EXAMPLES & USE SHOWCARD*	Yes 1 No 2	☐	*If No, go to P 12*
P 11a	If Yes, In a typical week, on how many days do you do vigorous activities as part of your *[leisure time]*?	Days a week	☐☐	
P 11b	How much time do you spend doing this on a typical day?	In hours and minutes OR in Minutes only	hrs ☐☐ : mins ☐☐ or minutes ☐☐☐	

P 12	In your [*leisure time*], do you do any moderate-intensity activities like brisk walking,[*cycling or swimming*] for at least 10 minutes at a time? *INSERT EXAMPLES & USE SHOWCARD*	Yes 1 No 2	☐	*If No, go to P 14*
P 13a	<u>If Yes</u> In a typical week, on how many days do you do moderate-intensity activities as part of [*leisure time*]?	Days a week	☐☐	
P 13b	How much time do you spend doing this on a typical day?	In hours and minutes OR in Minutes only	hrs ☐☐ : mins ☐☐ or minutes ☐☐☐	
The following question is about sitting or reclining. Think back over the past 7 days, to time spent at work, at home, in *[leisure]*, including time spent sitting at a desk, visiting friends, reading, or watching television, but do not include time spent sleeping.				
P 14	Over the past 7 days, how much time did you spend sitting or reclining on a typical day?	In hours and minutes OR in Minutes only	hrs ☐☐ : mins ☐☐ or minutes ☐☐☐	

Respondent Identification Number

EXPANDED : History of High Blood Pressure				
H 1	When was your blood pressure last measured by a health professional?	Within past 12 months 1 1-5 years ago 2 Not within past 5 yrs 3	☐	
H 2	During the past 12 months have you been told by a doctor or other health worker that you have elevated blood pressure or hypertension?	Yes 1 No 2	☐	*If No, skip to Next Section*
H 3	Are you currently receiving any of the following treatments for high blood pressure prescribed by a doctor or other health worker?			
H 3a	Drugs (medication) that you have taken in the last 2 weeks	Yes 1 No 2	☐	
H 3b	Special prescribed diet	Yes 1 No 2	☐	
H 3c	Advice or treatment to lose weight	Yes 1 No 2	☐	
H 3d	Advice or treatment to stop smoking	Yes 1 No 2	☐	
H 3e	Advice to start or do more exercise	Yes 1 No 2	☐	
H 4	During the past 12 months have you seen a traditional healer for elevated blood pressure or hypertension	Yes 1 No 2	☐	
H 5	Are you currently taking any herbal or traditional remedy for your high blood pressure?	Yes 1 No 2	☐	

EXPANDED : History of Diabetes				
H 6	Have you had your blood sugar measured in the last 12 months?	Yes 1 No 2	☐	
H 7	Have you ever been told by a doctor or other health worker that you have diabetes?	Yes 1 No 2	☐	*If No, skip to Next Section*
H 8	Are you currently receiving any of the following treatments for diabetes prescribed by a doctor or other health worker?			
H 8a	Insulin	Yes 1 No 2	☐	
H 8b	Oral drug (medication that you have taken in the last 2 weeks	Yes 1 No 2	☐	
H 8c	Special prescribed diet	Yes 1 No 2	☐	
H 8d	Advice or treatment to lose weight	Yes 1 No 2	☐	
H 8e	Advice or treatment to stop smoking	Yes 1 No 2	☐	
H 8f	Advice to start or do more exercise	Yes 1 No 2	☐	
H 9	During the past 12 months have you seen a traditional healer for diabetes?	Yes 1 No 2	☐	
H 10	Are you currently taking any herbal or traditional remedy for your diabetes?	Yes 1 No 2	☐	

Respondent Identification Number ☐☐ ☐☐ ☐☐

Step 2 Physical Measurements

Height and weight			Coding Column
M 1	Technician ID Code		☐☐☐
M 2a & 2b	Device IDs for height and weight	(2a) height ☐☐	(2b) weight ☐☐
M 3	Height	(in Centimetres)	☐☐☐.☐
M 4	Weight *If too large for scale, code 666.6*	(in Kilograms)	☐☐☐.☐
M 5	***(For women)*** Are you pregnant?	Yes 1 No 2	☐ *If Yes, Skip Waist*
Waist			
M 6	Technician ID		☐☐☐
M 7	Device ID for waist		☐☐
M 8	Waist circumference	(in Centimetres)	☐☐☐.☐

Blood pressure			Coding Column
M 9	Technician ID		☐☐☐
M 10	Device ID for blood pressure		☐☐
M 11	Cuff size used	Small 1 Normal 2 Large 3	☐
M 12a	Reading 1 **Systolic BP**	Systolic mmHg	☐☐☐
M 12b	**Diastolic BP**	Diastolic mmHg	☐☐☐
M 13a	Reading 2 **Systolic BP**	Systolic mmHg	☐☐☐
M 13b	**Diastolic BP**	Diastolic mmHg	☐☐☐
M 14a	Reading 3 **Systolic BP**	Systolic mmHg	☐☐☐
M 14b	**Diastolic BP**	Diastolic mmHg	☐☐☐
M 15	During the past two weeks, have you been treated for high blood pressure with drugs (medication) prescribed by a doctor or other health worker ?	Yes 1 No 2	☐

SELECTED EXPANDED ITEMS			
M 16	Hip circumference	(in Centimetres)	☐☐☐.☐
Heart Rate (Record if automatic blood pressure device is used)			
M 17a	Reading 1	Beats per minute:	☐☐☐
M 17b	Reading 2	Beats per minute:	☐☐☐
M 17c	Reading 3	Beats per minute:	☐☐☐

Respondent Identification Number ☐☐ ☐☐ ☐☐

Step 3 Biochemical Measurements

CORE	Blood glucose		Coding Column
B 1	During the last 12 hours have you had anything to eat or drink, other than water?	Yes 1 No 2	☐
B 2	Technician ID Code		☐☐☐
B 3	Device ID code		☐☐
B 4	Time of day blood specimen taken (24 hour clock)		hrs ☐☐ : mins ☐☐
B 5	Blood glucose	Low 1 High 2 Unable to assess 3	mmol/l ☐☐.☐ ☐
CORE	**Blood Lipids**		
B 6	Technician ID Code		☐☐☐
B 7	Device ID code		☐☐
B 8	Total cholesterol	Low 1 High 2 Unable to assess 3	mmol/l ☐☐.☐☐ ☐

SELECTED EXPANDED ITEMS			
B 9	Technician ID Code		☐☐☐
B 10	Device ID code		☐☐
B 11	Triglycerides	Low 1 High 2 Unable to assess 3	mmol/l ☐☐.☐☐ ☐
B 12	Technician ID Code		☐☐☐
B 13	Device ID code		☐☐
B 14	HDL Cholesterol	Low 1 High 2 Unable to assess 3	mmol/l ☐.☐☐ ☐

Appendix 2C: The Can Tho STEPS instrument (back translated)

QUESTIONNAIRE
SURVEY ON RISK FACTOR OF NON-COMMUNICABLE DISEASES

General information:

I4 Interviewer ID: ....

I12 Telephone number of interviewee: ....

I5 Date of interview: day *...... month .... year........*

I9 Start time of interview: *....... hh.......mm*

I9a Finish time of interview: *....... hh.......mm*

Table for age from horoscope

Mice	Buffalo	Tiger	Cat	Dragon	Snake	Horse	Goat	Monkey	Chicken	Dog	Pig	**Thập Can**
Tí	**Sửu**	**Dần**	**Mẹo**	**Thìn**	**Tị**	**Ngọ**	**Mùi**	**Thân**	**Dậu**	**Tuất**	**Hợi**	Giáp
9	8	7	6	5	4	3	2	1	0			Ất
21	20	19	18	17	16	15	14	13	12	11	10	Bính
33	**32**	**31**	**30**	**29**	**28**	**27**	**26**	**25**	24	23	22	Đinh
45	**44**	**43**	**42**	**41**	**40**	**39**	**38**	**37**	**36**	**35**	**34**	Mậu
57	**56**	**55**	**54**	**53**	**52**	**51**	**50**	**49**	**48**	**47**	**46**	Kỉ
69	68	67	66	65	**64**	**63**	**62**	**61**	**60**	**59**	**58**	Canh
81	80	79	78	77	76	75	74	73	72	71	70	Tân
93	92	91	90	89	88	87	86	85	84	83	82	Nhâm
105	104	103	102	101	100	99	98	97	96	95	94	Quý

Subject ID: | | | |
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STEP 1: Demographic information

				Coding column
C1	Sex (*Record Male/Female as observed*)	Male 1 Female 2		☐
C2	What is your date of birth? *(if known, go to C4)*	Day ....month.........year............		
C3	How old are you?	Years	....	
C4	In total, how many years have you spent at school or in full-time study (excluding pre-school)?	Years	....	
C6	What is the highest level of education you have completed?	No formal schooling Less than primary school Primary school Secondary school High school Prof school College/university Post graduate	1 2 3 4 5 8 6 7	☐
C5	What is your ethnic group?	Vietnamese Chinese Khmer Others (state)	1 2 3 4	☐ ....
C7	Which of the following best describe your main work status in the last 12 months?	Government employee NGO employee Self-employed Non-paid Student Housewife Retired Unemployed Disable Unstable employed	1 2 3 4 5 6 7 8 9 10	☐
C7a	Which of the following best describe your work type in the last 12 months?	Farmer Industrial worker Clerk Carpenter Handicraft Construction Trader Others (state)	1 2 3 4 5 6 7 8	☐ ....
C8	How many people older than 18 years, including yourself, live in your household? **(in the last 3 months)**	Number of people		☐☐
C9	Taking the last year, can you tell me	In a week	....	

	what the average earnings of the household have been? Use any option that is convenient for interviewee.	In a month In a year Refuse*	…………………… …………………… ☐
C10	***If C9 is refused, then ask:*** Can you give me an estimate income per person per month if I read some options to you? Is it:	< 100.000 100.000-299.999 300.000-499.999 500.000-699.999 ≥ 700.000 Refuse	1 2 3 4 5 8 ☐
C11	Is the above income enough for basic need of the household? (disregard health care cost)	Yes 1 No 2	☐

Step 1: Core behavioural measures

CORE Tobacco Use (Section S)

Now I am going to ask you some questions about various health behaviours. This includes things like smoking, drinking alcohol, eating fruits and vegetables and physical activity. Let's start with smoking.

		Answer	Coding column	
S1a	Do you currently smoke any **tobacco products**, such as cigarettes, cigars or pipes?	Yes 1 No 2	☐	*If no, go to S4*
S1b	**<u>If Yes,</u>** Do you currently smoke tobacco products **daily**?	Yes 1 No 2	☐	*If no, go to S4*
S2a	How old were you when you **first started** smoking daily?	Age (year) Not known 77	☐☐	*If known, go to S3*
S2b	**<u>If S2a=77:</u>** How long have you been smoking? (choose 1 in 3, code 77 if not known)	In years Or in months Or in week	Year ☐☐ Month ☐☐ Week ☐☐	
S3	On average, **how many** of the following do you smoke each day? (Record for each type) (Code 88 for not applicable)	Manufactured cigarette Hand-rooled cigarette Pipes full of tobacco Water tube tobacco Others (state)	☐☐ ☐☐ ☐☐ ☐☐ ………………	*Go to S5c*

EXPANDED: Tobacco Use

S4	In the past, did you **ever** smoke	Yes 1		*If no, go to*

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	daily?	No 2		S6a
S4a	**If yes,**, How old were you when you **started** smoking daily?	Age (year) Not known 77		*If known, go toS5a*
S4b	**If S4a=77:** How long had you been smoking? (choose 1 in 3, code 77 if not known)	In years Or in months Or in week	Year Month Week	
S5a	How old were you when you **stopped** smoking **daily**?	Age (year) Not known 77		*If known, go to S5c*
S5b	How **long ago** did you stop smoking daily?	In years Or in months Or in week	Year Month Week	
S5c	When smoking, how often do you inhale the smoke deeply?	Often 1 Sometimes 2 Never 3		
S6a	Do you **currently use** any **smokeless tobacco** such as chewing tobacco?	Yes 1 No 2		*If no, go to S8*
S6b	**If Yes,** Do you **currently use smokeless tobacco** products **daily?**	Yes 1 No 2		*If no, go to S8*
S7	On average, how many **times a day** do you use chewing tobacco	Number of times		
S8	In the past, did you **ever use** smokeless tobacco such as chewing tobacco **daily**?	Yes 1 No 2		
S9	Do you currently expose to smoke from other's smoking daily?	Yes 1 No 2		

CORE Alcohol Consumption (Section A)				
The next questions the consumption of alcohol				
		Answer	**Coding column**	
A1a	Have you **ever consumed** a drink that contains alcohol such as beer, wine, spirit, fermented cider or rice wine? *USE SHOWCARD or SHOW EXAMPLES*	Yes 1 No 2	☐	*If no, go to section D*
A1b	Have you consumed alcohol within the **past 12 months**?	Yes 1 No 2	☐	*If no, go to section D*
A2	In the past 12 months, **how frequently** have you had at least one drink? *(READ RESPONSES)* *USE SHOWCARD*	5+ days a week 1 1-4 days per week 2 1-3 days a month 3 < once a month 4	☐	
A3	When you drink alcohol, **on average**, how many drinks do you have during one day?	Number Don't know 7 7	☐☐	
A4	During each of the **past 7 days**, how many standard drinks of any alcoholic drink did you have each day? *(RECORD FOR EACH DAY* *USE SHOWCARD)*	Monday Tuesday Wednesday Thursday Friday Saturday Sunday	☐☐ ☐☐ ☐☐ ☐☐ ☐☐ ☐☐ ☐☐	

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EXPANDED: ALCOHOL			
A5	In the past 12 months, what was the **largest number** of drinks you had on a single occasion, counting all types of standard drinks together?	Largest number	☐☐
A6a	<u>**For men only:**</u> In the past 12 months, on how many days did you have **five or more** standard drinks in a single day?	Number of days	☐☐☐
A6b	<u>**For women only**</u>: In the past 12 months, on how many days did you have **four or more** standard drinks in a single day?	Number of days	☐☐☐

CORE Diet (Section D)				
The next questions ask about the fruits and vegetables that you usually eat. I have a nutrition card here that shows you some examples of local fruits and vegetables. Each picture represents the size of a serving. As you answer these questions please think of a typical week in the last year.				
D1a	In a typical week, on how many days do you **eat fruit**? *USE SHOWCARD*	Number of days	☐	If 0 day, go to D2a
D1b	How many **servings** of fruit do you eat on **one** of those days? *USE SHOWCARD*	Number of servings	☐☐	
D2a	In a typical week, on how many days do you **eat vegetables**? *USE SHOWCARD*	Number of days	☐	*If 0 day, go to D3*
	How many **servings** of vegetables do you eat on one of those days? *USE SHOWCARD*			
D2b1	Which size of bowl do you use for eating?	Large (330ml) 1 Medium (200ml) 2 Small (150ml) 3	☐	
D2b2	Uncooked vegetable	Number of bowl	☐☐	
D2b3	Cooked vegetable	Number of bowl	☐☐	

EXPANDED: Diet			
D 3	What type of **oil or fat is most often** used for meal preparation in your household? *USE SHOWCARD* *SELECT ONLY ONE*	Vegetable oil 1 Lard or suet 2 Butter or ghee 3 Margarine 4 Other 5 None in particular 6 None used 7 Don't know 9	☐ …………………
D4	In a typical week, how many day do you eat each of the following?	Meat with fat	
		Egg	
		Dairy product	
		Fish or seafood	
		Fermented fish	
		Dried fish	
		Fermented vegetable	
		Fermented soybean	
		Salty egg	
		Candy or sweet cookies	
D5a	In a typical week, how many days do you have fried food?	Number of days	☐
D5b	In a typical week, how many days do you have salty food?	Number of days	☐
D6	Are you considered eating more salty food than others in the family?	Yes 1 No 2	☐

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CORE - Physical Activity (Section P)				
Next I am going to ask you about the time you spend doing different types of physical activity. Please answer these questions even if you do not consider yourself to be an active person. Think first about the time you spend doing your work. Think of work as the things that you have to do such as paid or unpaid work, household chores, harvesting food, fishing or hunting for food, seeking employment.				
P 1	Does your work involve mostly sitting or standing, with walking for no more than 10 minutes at a time?	Yes 1 No 2	☐	*If yes, go to P6*
P 2	Does your work involve vigorous activity, like [*heavy lifting, digging or construction work*] for at least 10 minutes at a time? *INSERT EXAMPLES & USE SHOWCARD*	Yes 1 No 2	☐	*If no, go to P4*
P 3a	In a typical week, on how many days do you do vigorous activities as part of your work?	Days a week	☐	
P 3b	On a typical day on which you do vigorous activity, how much time do you spend doing such work?	In hours and minutes OR in minutes only	☐☐ ☐☐ ☐☐☐	
P 4	Does your work involve moderate-intensity activity, like brisk walking [*or carrying light loads*] for at least 10 minutes at a time? *INSERT EXAMPLES & USE SHOWCARD*	Yes 1 No 2	☐	*If no, go to P6*
P 5a	In a typical week, on how many days do you do moderate-intensity activities as part of your work?	Days a week	☐	
P 5b	On a typical day on which you did moderate-intensity activities, how much time do you spend doing such work?	In hours and minutes OR in minutes only	☐☐ ☐☐ ☐☐☐	

P 6	How long is your typical work day?	Number of hours	☐☐	
Other than activities that you've already mentioned, I would like to ask you about the way you travel to and from places. For example to work, for shopping, to market, to pagoda or temples...				
P 7	Do you walk or use a bicycle (*pedal cycle*) for at least 10 minutes continuously to get to and from places?	Yes 1 No 2	☐	*If no, go toP9*
P 8a	In a typical week, on how many days do you walk or bicycle for at least 10 minutes to get to and from places?	Days a week	☐	
P 8b	How much time would you spend walking or bicycling for travel on a typical day?	In hours and minutes OR in minutes only	☐☐ ☐☐ ☐☐☐	
The next questions ask about activities you do in your leisure time. Think about activities you do for recreation, fitness or sports. Do not include the physical activities you do at work or for travel mentioned already.				
P 9	Does your [*recreation, sport or leisure time*] involve mostly sitting, reclining, or standing, with no physical activity lasting more than 10 minutes at a time?	Yes 1 No 2	☐	*If yes, go to P14*
P 10	In your [*leisure time*], do you do any vigorous activities like [*running or strenuous sports, weight lifting*] for at least 10 minutes at a time? *INSERT EXAMPLES & USE SHOWCARD*	Yes 1 No 2	☐	*If no, go to P 12*
P 11a	If Yes, In a typical week, on how many days do you do vigorous activities as part of your [*leisure time*]?	Days a week	☐	
P 11b	How much time do you spend doing this on a typical day?	In hours and minutes OR in minutes only	☐☐ ☐☐ ☐☐☐	

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P 12	In your [*leisure time*], do you do any moderate-intensity activities like brisk walking, [*cycling or swimming*] for at least 10 minutes at a time? *INSERT EXAMPLES & USE SHOWCARD*	Yes 1 No 2	[ ]	*If no, go to P 14*
P 13a	<u>If Yes</u> In a typical week, on how many days do you do moderate-intensity activities as part of [*leisure time*]?	Days a week	[ ][ ]	
P 13b	How much time do you spend doing this on a typical day?	In hours and minutes OR in minutes only	[ ][ ] [ ][ ] [ ][ ][ ]	

The following question is about sitting or reclining. Think about the past 7 days, the time spent at work, at home, in *[leisure]*, including time spent sitting at a desk, visiting friends, reading, or watching television, but **do not include time spent sleeping**.

P 14	Over the past 7 days, how much time did you spend sitting or reclining on a typical day?	In hours and minutes OR in minutes only	[ ][ ] [ ][ ] [ ][ ][ ]	

EXPANDED : History of High Blood Pressure

H 1	When was your blood pressure last measured by a health professional?	Within past 12 months 1 1-5 years ago 2 Not in past 5 yrs 3	[ ]	
H 2	During the past 12 months have you been told by a doctor or other health worker that you have elevated blood pressure or hypertension?	Yes 1 No 2	[ ]	*If no, go to H6*
H 3	Are you currently receiving any of the following treatments for high blood pressure prescribed by a doctor or other health worker?			
H 3a	Drugs (medication) that you have taken in the last 2 weeks	Yes 1 No 2	[ ]	

H 3b	Special prescribed diet	Yes 1 No 2	☐
H 3c	Advice or treatment to lose weight	Yes 1 No 2	☐
H 3d	Advice or treatment to stop smoking	Yes 1 No 2	☐
H 3e	Advice to start or do more exercise	Yes 1 No 2	☐
H 4	During the past 12 months have you seen a (trained, certified) traditional healer for elevated blood pressure or hypertension	Yes 1 No 2	☐
H 5	Are you currently taking any herbal or traditional remedy for your high blood pressure?	Yes 1 No 2	☐

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EXPANDED : History of Diabetes				
H 6	Have you had your blood sugar measured in the last 12 months?	Yes 1 No 2	☐	
H 7	Have you ever been told by a doctor or other health worker that you have diabetes?	Yes 1 No 2	☐	*If no, go to O1*
H 8	Are you currently receiving any of the following treatments for diabetes prescribed by a doctor or other health workers?			
H 8a	Insulin	Yes 1 No 2	☐	
H 8b	Oral drug (medication that you have taken in the last 2 weeks	Yes 1 No 2	☐	
H 8c	Special prescribed diet	Yes 1 No 2	☐	
H 8d	Advice or treatment to lose weight	Yes 1 No 2	☐	
H 8e	Advice or treatment to stop smoking	Yes 1 No 2	☐	
H 8f	Advice to start or do more exercise	Yes 1 No 2	☐	
H 9	During the past 12 months have you seen a traditional healer for diabetes?	Yes 1 No 2	☐	
H10	Are you currently taking any herbal or traditional remedy for your diabetes?	Yes 1 No 2	☐	

O1	Have you ever been told by a **doctor/health worker** that you have stroke?	Yes 1 No 2	☐
O2	Have you ever been told by a **doctor/health worker** that you have heart diseases (such as angina, heart attack)?	Yes 1 No 2	☐
O3a	Have you ever had a serious health problem (hospitalized at least a week, serious surgery)?	Yes 1 No 2	☐
O3b	If yes, what was that?	State: 1/... 2/...	

Subject ID: [ ][ ] [ ][ ] [ ][ ][ ]

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Step 2 Physical Measurements

Height and weight			**Coding column**	
M 1	Technician ID		[ ][ ]	
M2	Device IDs for height and weight		[ ]	
M 3	Height	(cm)	[ ][ ][ ].[ ]	
M 4	Weight *If too large for scale, code 666.6*	(kg)	[ ][ ][ ].[ ]	
M 5	***(For women)*** Are you pregnant ?	Yes 1 No 2	[ ]	*If yes, skip waist*
Waist and hip circumferences				
M 6	Technician ID		[ ][ ]	
M 7	Device IDs for waist and hip		[ ]	
M 8	Waist circumference	(cm)	[ ][ ][ ].[ ]	
M 16	Hip circumference	(cm)	[ ][ ][ ].[ ]	

Blood Pressure			Coding column
M 9	Technician ID		
M 10	Device ID for blood pressure		
M11a	Mid-arm circumference		cm
M 11	Cuff size used	Small (<22cm) 1 Medium (22 – 31.9cm) 2 Large (32- 42cm) 3	
M11b	Room temperature when blood pressure is taken		^{0}C
M 12a	Reading 1 **Systolic BP**	Systolic mmHg	....
M 12b	**Diastolic BP**	Diastolic mmHg	....
M 13a	Reading 2 **Systolic BP**	Systolic mmHg	....
M 13b	**Diastolic BP**	Diastolic mmHg	....
M 14a	Reading 3 **Systolic BP**	Systolic mmHg	....
M 14b	**Diastolic BP**	Diastolic mmHg	....
M 15	During the last two weeks, have you been treated for high blood pressure with drugs (medication)?	Yes 1 No 2	

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Step 3 Biochemical Measurements

CORE	Blood glucose		Coding Column
B 1	During the last 12 hours have you had anything to eat or drink, other than water?	Yes 1 No 2	☐
B 2	Technician ID Code		☐☐
B 3	Device ID code		☐
B 4	Time of day blood specimen taken (24 hour clock)		hh:........mm:....
B 5	Blood glucose	Low 1 High 2 Unable to assess 3	.............mmol/l ☐
B5a	Blood glucose, second reading (if first reading is low or high)	Low 1 High 2 Unable to assess 3	.............mmol/l ☐

CORE	Blood Lipids		
B6	Technician ID Code		☐☐
B7	Device ID code		☐
B8	Total cholesterol	Low 1 High 2 Unable to assess 3	...........mmol/l ☐
B8a	Total cholesterol, second reading (if the first reading is low or high)	Low 1 High 2 Unable to assess 3	...........mmol/l ☐

Chapter 3: Reliability and validity of the Global Physical Activity Questionnaire in Vietnam.

3.1 Preface

In the previous chapter, information on the prevalence of risk factors for noncommunicable diseases (NCD) in the population of 25-64 year old residents of Can Tho in the Mekong Delta, Vietnam was presented. The information was collected in a population-based survey of n=1978 participants conducting using the WHO STEPwise approach to surveillance of risk factors for non-communicable diseases (STEPS) methodology. The survey included measurement of physical activity by the Global Physical Activity Questionnaire (GPAQ).

In this chapter the reliability and validity of measurements by GPAQ of physical activity in the Vietnamese population is assessed. The approach is to compare the test re-test reliability of GPAQ with that of the International Physical Activity Questionnaire (IPAQ), and examine the validity correlations of the questionnaire estimates with physical activity record (PAR) and pedometer estimates of physical activity. To examine the usefulness of the GPAQ's "typical week" reference period, the estimates of physical activity by GPAQ are presented for participants with stable and unstable work patterns separately.

The text that follows has been published in a peer-reviewed journal (56). Additional analyses not included in the published text are included in Appendix 3A.

3.2 Introduction

Together with other changes in lifestyle during industrialisation and urbanisation, physical inactivity is likely to be an important contributor to the growing burden of non-communicable diseases in developing countries such as Vietnam (4). This provides a need to monitor levels and trends in physical activity participation, as has been done for the past few decades in many developed countries.

An adequate surveillance instrument for developing populations would need to be sufficiently sensitive to capture variation in possibly low levels of physical activity in industrialised settings yet sufficiently versatile to capture the diversity of activity in rural settings, where work patterns tend to change according to season and progress of crops. This may make it difficult to accurately measure habitual physical activity patterns among such populations using currently available instruments, which have been largely designed for use among Western populations.

Currently, there are two questionnaires that have been developed for use in developing populations: the International Physical Activity Questionnaire (IPAQ) and the Global Physical Activity Questionnaire (GPAQ). The IPAQ was developed as the first international effort to provide a comparable self-report measure of physical activity across countries and settings (34). It has been intensively tested and found to have reasonable reliability and validity (76-80). The long version collects information within the domains of occupational activities, household and yard-work activities, self-powered transport, and leisure time activity. For those who currently do not have paid work or unpaid work outside their home, the occupational domain is skipped. The questionnaire also has additional questions on sedentary activity (81).

The GPAQ was developed by the World Health Organization (WHO) following a review of existing physical activity questionnaires, particularly IPAQ, for their usefulness in the developing country setting (82). It is one component in the STEPS methodology that is designed for use in population surveys of non-communicable disease risk factors (32). GPAQ is a compromise between the short (9 questions) and long (27 questions) versions of IPAQ. It is a 14-item questionnaire designed to measure three domains of physical activity: work (paid and unpaid activities inside and outside the home), transport, and recreation or leisure. Information is sought on time spent in moderate-intensity and vigorous-intensity activities within each domain. There are additional questions on time spent in sedentary activity. It differs from IPAQ in two major ways. Firstly, whereas work activities and household activities constitute separate domains of IPAQ, they are combined in the work domain of GPAQ. Secondly, GPAQ focuses on physical activity in a 'typical week', whereas IPAQ focuses on 'the last seven days'. Additionally, GPAQ includes walking in moderate intensity activity whilst IPAQ assesses walking separately.

Despite being used in many countries (54, 83-85), GPAQ has been tested in only one cross-country study from which detailed findings are not yet published (82). It is not known whether GPAQ is an appropriate instrument to measure total physical activity in a country where a substantial proportion of the people have unstable work patterns. This study aimed to compare the reliability and validity of GPAQ and IPAQ using a sub-sample of participants in a STEPS survey of the population of Can Tho in southern Vietnam.

3.3 Methods

Sample

The Can Tho STEPS survey selected 2683 eligible subjects aged 25-64 years using stratified multi-stage sampling. Measurements consisted of behavioural risk factors (smoking, alcohol consumption, fruit and vegetable consumption and physical activity); physical measurement (weight, height, waist and hip circumferences, and blood pressure); and blood biochemistry (fasting total cholesterol and fasting blood glucose). The STEPS instrument was translated and measures were performed in accordance with the STEPS protocols (86). Findings from that study have been presented in Chapter 2 and have been published (55, 58).

Subjects of this study were selected as follows. Firstly, simple random sampling was used to select three rural and three urban communes from the eight rural and eight urban communes selected in the population survey. Systematic random sampling was then used to select every third person from the list of eligible subjects of each of the six selected communes. Of the 325 eligible subjects chosen, 77.2% (251/325) presented at survey clinics and participated in this study. At the second contact, 96.4% (242/251) of them participated. The process of recruitment is described in Figure 3.1. The timeline of data collection is explained in Figure 3.2 and Figure 3.3.

Written informed consent was obtained from participants. The Ethics Committee of Can Tho University of Medicine and Pharmacy approved the study. Data collection was carried out from July to December 2005.

Measurements

At the clinics, GPAQ and IPAQ were administered face-to-face by trained interviewers. Participants then wore pedometers and completed a physical activity record (PAR) for seven consecutive days. Three weeks after the clinic, GPAQ and IPAQ were re-administered at a home visit. GPAQ was administered before IPAQ by different interviewers at both administration time-points.

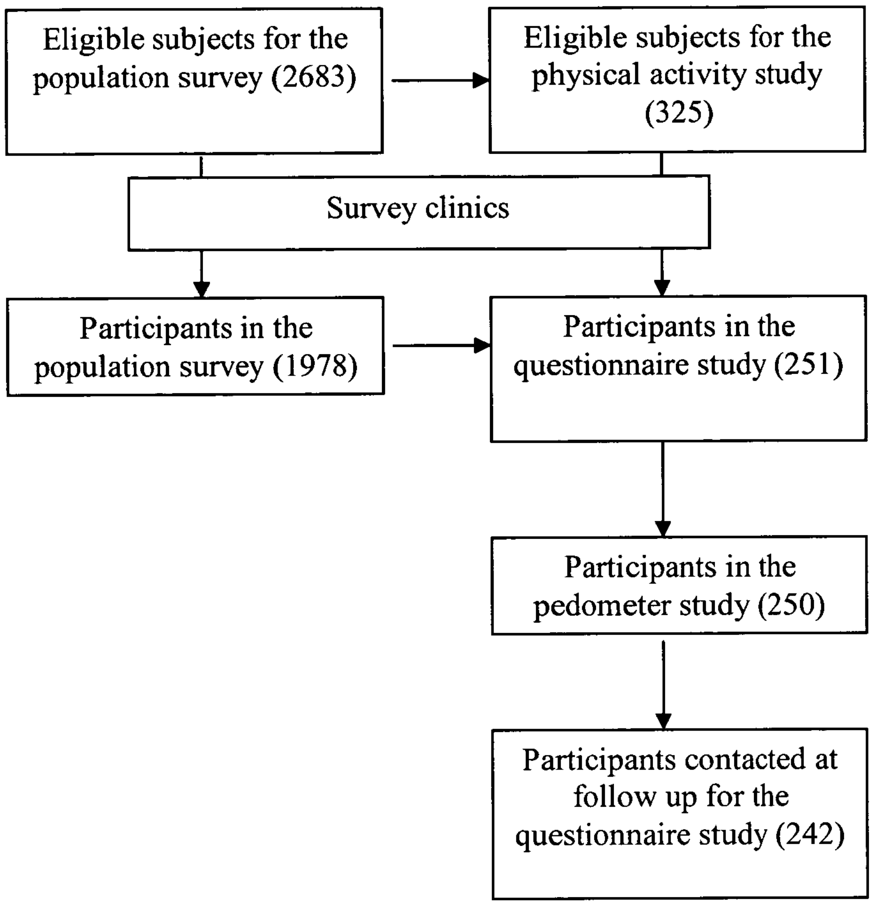

Figure 3.1: Recruitment and participation flow chart.

The questionnaires were translated and back-translated by independent translators. Care was taken to ensure that the words retained their meaning and were culturally sensitive. Show cards with examples of local activities were used to help participants understand the questions in GPAQ. The version of IPAQ used was the long format, telephone, last seven days (81) (see Appendix 3B). The Vietnamese version of the IPAQ-L (long version) used in this study was approved and posted on the IPAQ website (87). A comparison of GPAQ and IPAQ wording is presented in Appendix 3A.

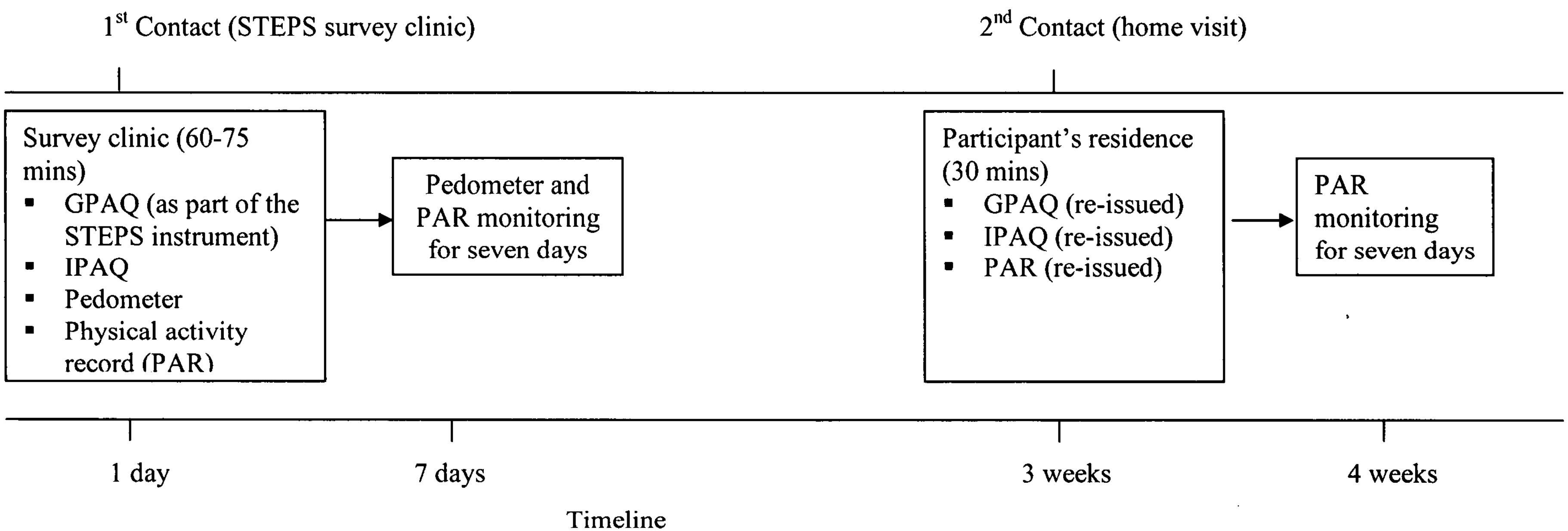

Figure 3.2: Data collection timeline of the physical activity study.

	Site															
STEPS survey	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Physical activity study		1			2		3		4		5		6			

Figure 3.3: Data collection timeline of the physical activity study relative to the population survey.
Note: The STEPS survey clinics were held every weekend for 16 weeks.

The Yamax SW-200 pedometers used in this study have been shown to have superior accuracy and reliability (88, 89). Participants were instructed to attach the pedometer to their belt or waistband at the right hip, to reset it each morning, and to record their steps each day and the times it was worn. The pedometers were tested for accuracy before and after each use. Faulty pedometers were removed from use. Details of pedometer usage are presented in Chapter 4.

The PAR was developed based on the format of the log book used in the Burnie Take Heart Project by the Menzies Research Institute (35). In the PAR, participants recorded all activities undertaken each day from waking in the morning to going to bed, including those activities undertaken whilst not wearing the pedometer. This required them to record the time that each activity commenced and concluded, provide a short description of the activities, and record their intensity (low, moderate, or vigorous). Local health volunteers were available to provide assistance to participants if they had any difficulties with completing the PAR or the pedometer diary.

Statistical methods

Data on self-reported physical activity were coded and scored according to the established GPAQ (90) and IPAQ (91) guidelines. Hours of physical activity were weighted by the Metabolic Equivalent Task (MET) score prescribed in these guidelines for the type of activity undertaken. Only participants who completed at least three days of pedometer wear were included in the analyses using pedometer measurements (92). Each activity reported in the PAR was assigned the MET score of the most similar activity listed in the Compendium of Physical Activities (93). The MET-weighted total hours of each listed activity was calculated by multiplying the activity duration by its MET score. These were summed across all activities to calculate total MET-weighted hours of physical activity.

Because the physical activity measures were right skewed, medians as well as means are presented. Spearman rank correlation coefficients were used to summarise the associations between the different measures of physical activity and the associations between the first and second measurements made from GPAQ and IPAQ.

The reliability of the measurement of physical activity by GPAQ and IPAQ were compared for participants grouped according to the stability of their work patterns. Whether or not a participant's occupation involved job tasks that would vary from week to week was determined from participants' description of their work activities. Workers deemed to have stable work patterns were farmers (men), industrial workers, construction workers and clerks, and traders (women). Workers with unstable work patterns were farmers (women), traders (men), and homemakers (women). The classification of others such as bicycle repairers or street barbers (stable pattern) and odd-job men (unstable pattern) was determined on a case-by-case basis. The different classifications of farmers and traders for men and women deserve further comments. For farmers, the common practice is for women to participate in farm work during periods of harvest and return to domestic duties at other times. For traders, such as market stallholders and street vendors, the common practice is for men to hold other jobs (unstable pattern) but for this to be the sole activity for women (stable pattern). Overall, except for those who had employment outside their homes including self-employed activities such as those of a street vendor, women reported having activities that varied significantly from week to week. In comparison, most men had a stable work pattern.

Concurrent validity (94) was assessed from the correlations between each questionnaire's total physical activity measurements with that of: (1) the other questionnaire; (2) steps per day from pedometer recordings; and (3) MET hours per week estimated from the PAR. Predictive validity (94) of GPAQ and IPAQ was examined using the correlations of their physical activity measures with CVD risk indicators.

3.4 Results

The characteristics of study participants in the sub-sample and the population survey sample are described in Table 3.1. Overall, the sub-sample was dominated by persons who did not complete secondary school, were farmers and had a normal body mass index (BMI) according to WHO classification (18.5 kg/m$^2 \leq$ BMI < 25 kg/m^2) (95). They did not differ in these respects from the full sample of participants in the population survey (data not shown).

Table 3.1: Characteristics of participants in this sub-sample.

	Men (n=124) % (Num)	Women (n=127) % (Num)
Age		
25-34 years	16.1 (20)	22.1 (28)
35-44 years	25.0 (31)	24.4 (31)
45-54 years	33.9 (42)	27.6 (35)
55-64 years	25.0 (31)	26.0 (33)
Education*		
Pre-primary school	33.9 (42)	66.1 (84)
Primary school	35.5 (44)	24.4 (31)
Secondary school	16.9 (21)	5.5 (7)
High school	8.1 (10)	1.6 (2)
Post high school	5.6 (7)	2.4 (3)
Job description		
Farmer	51.6 (64)	32.3 (41)
Industrial worker	2.4 (3)	0 (0)
Clerk	4.0 (5)	1.6 (2)
Construction	4.0 (5)	0.8 (1)
Trader	8.1 (10)	22.8 (29)
Home maker	0.8 (1)	24.4 (31)
Others†	29.0 (36)	18.1 (23)
Body mass index		
<18.5 kg/m^2	21.8 (27)	23.6 (30)
18.5-19.9 kg/m^2	21.8 (27)	15.8 (20)
20.0-22.9 kg/m^2	34.7 (43)	27.6 (35)
23.0-24.9 kg/m^2	13.7 (17)	16.5 (21)
25.0+ kg/m^2	8.1 (10)	16.5 (21)

* Highest level of education completed

† Other occupations included motorbike drivers, barbers, teachers, and those who repaired shoes.

Table 3.2 presents physical activity and sitting time reported by questionnaires, as well as steps per day and MET data from the PAR. There were unsatisfactory floor effects for some categories of the measurements by questionnaire, with many participants reporting no moderate and/or vigorous physical activity at all.

More physical activity was reported at the second administration of each questionnaire, particularly GPAQ. Further investigation of factors associated with these increases identified differences between participants classified by whether or not they had stable work patterns (see Methods). In our sample, 79% (95/120) of men and 43% (51/118) of women had stable work patterns. Participants who reported increased physical activity in the second administration of IPAQ tended to also report increased physical activity in the second administration of GPAQ if they had unstable work pattern. The correlations between the increase in physical activity measured by GPAQ and by IPAQ were $r = 0.05$ for persons with stable work patterns, and $r = 0.38$ for those with unstable work patterns.

Work physical activity measured by GPAQ was less than the sum of work and domestic physical activity by IPAQ. This difference was most marked for women, for whom domestic activities constituted the largest component of total physical activity measured by IPAQ. For each questionnaire, transport and leisure time physical activity constituted only a small portion of total physical activity.

Figure 3.4 shows male-to-female ratios of median levels of total physical activity measured in the first administrations of GPAQ (GPAQ1) and IPAQ (IPAQ1), and by pedometers and the PAR. The median of total physical activity reported by men was more than twice the median of total physical activity reported by women using GPAQ1, but the measurements made using the other three instruments (IPAQ1, pedometers, PAR) were similar for men and women.

The test-retest reliability coefficients for GPAQ and IPAQ are shown in Table 3.3. For total physical activity, the pairs of measurements were more highly correlated for men than for women. Although GPAQ focuses on physical activity in a typical week, the test-retest correlations of its measurements of total physical activity were much higher for men and women with stable work patterns ($r = 0.39$) than for the remaining participants with unstable work patterns ($r = -0.05$). On the other hand, IPAQ produced more similar correlations in each of the two groups (stable work patterns $r = 0.33$, unstable work patterns $r = 0.16$).

For GPAQ measurements of work physical activity, the test re-test correlations were also much higher for persons with stable ($r = 0.43$) rather than unstable ($r = -0.02$) work patterns. The corresponding correlations for IPAQ, combining the two separate domains

Table 3.2: Measurements of physical activity by the Global Physical Activity Questionnaire (GPAQ), the International Physical Activity Questionnaire (IPAQ), steps per day recorded by pedometer, and a physical activity record (PARTICIPANTS) of daily activities.

	Men						Women					
	Administration 1			Administration 2			Administration 1			Administration 2		
	Mean	Median	IQR*	Mean	Median	IQR*	Mean	Median	IQR*	Mean	Median	IQR*
GPAQ												
Hours/week												
Vigorous	4.2	0	0,0	8.3	1.0	0,13.0	1.2	0	0,0	2.0	0	0,0
Moderate	16.0	7.1	0.8,26.8	18.6	13.7	2.4,28.3	17.6	7.0	0,30.0	17.9	10.8	3.4,28.0
Total	20.2	13.5	2.0,33.5	26.9	22.8	4.0,42.2	18.8	7.0	0,31.5	19.8	14.0	3.7,29.1
MET-hours/week†												
Work	80.7	23.3	0,128.0	120.8	84.0	0,188.0	65.7	0	0,112.0	73.2	52.0	0,112.0
Transport	14.8	4.8	0,14.0	13.8	2.7	0,12.0	11.5	4.0	0,14.0	11.1	4.0	0,14.0
Leisure	2.1	0	0,0	6.5	0	0,4.7	3.1	0	0,0	3.0	0	0,0
Total	97.6	58.7	8.2,148.7	141.3	112.0	23.0,214.0	79.8	28.0	0,140.0	87.3	60.0	16.3,123.3
Sitting‡	3.7	3.0	2.0,5.0	4.1	4.0	2.5,5.0	3.2	2.0	1.0,4.0	3.9	3.0	2.0,5.0
IPAQ												
Hours/week												
Vigorous	6.7	0	0,4.5	8.1	0	0,10.5	3.6	0	0,0	1.8	0	0,0
Moderate	15.5	8.4	0.9,24.1	18.6	8.1	1.6,28.8	21.3	17.5	3.5,34.0	21.5	15.0	5.3,32.5
Walk	4.3	1.3	0,4.7	3.8	1.0	0,3.5	2.6	0.3	0,2.8	3.6	1.7	0,4.0
Total	25.9	21.0	4.0,37.5	30.4	26.0	5.5,49.0	27.9	24.5	7.0,44.0	27.0	21.5	8.7,40.5
MET-hours/week†												
Work	68.0	0	0,105.0	98.8	10.6	0,202.5	38.3	0	0,28.0	32.4	0	0,27.7
Domestic	35.7	8.3	0,42.5	27.8	0	0,34.8	55.3	35.0	0,84.0	53.4	32.3	8.0,84.0
Transport	19.2	3.3	0,21.0	13.2	0	0,14.0	10.4	3.3	0,12.0	9.5	3.3	0,13.2
Leisure	6.5	0	0,5.8	8.7	0	0,9.6	5.8	0	0,1.7	5.1	0	0,3.9
Total	121.9	79.9	16.0,190.4	149.7	107.2	25.6,280.0	111.0	84.0	22.4,157.4	101.1	87.6	29.2,145.8

Sitting												
Week day§	4.0	3.5	2.5,5.0	4.2	3.5	3.0,5.0	4.2	4.0	3.0,5.0	4.2	4.0	2.3,5.0
Weekend day‖	4.1	3.5	2.5,5.0	4.2	3.5	3.0,5.0	4.4	4.0	3.0,6.0	4.1	3.8	2.3,5.0
Steps per day	10133.2	8746.3	6784.7,12734.7				9839.3	9743.9	6922.0, 12696.9			
Activity record†												
MET<3¶	116.9	105.2	84.2,153.1				138.2	135.3	115.4,166.8			
MET ≥ 3**	155.8	152.3	50.8,224.9				108.3	92.2	39.0,163.0			
Total	272.7	260.5	206.8, 316.8				246.5	233.7	207.4, 275.2			

*Inter-quartile range.
†Metabolic Equivalent Task (MET) units in hour per week.
‡ Sitting time (hours) on a typical day in the last seven days.
§ Sitting time (hours) on a usual weekday in the last seven days.
‖ Sitting time (hours) on a usual weekend day in the last seven days.
¶ Low intensity activity (MET < 3)
** Moderate and vigorous intensity activity (MET ≥ 3)

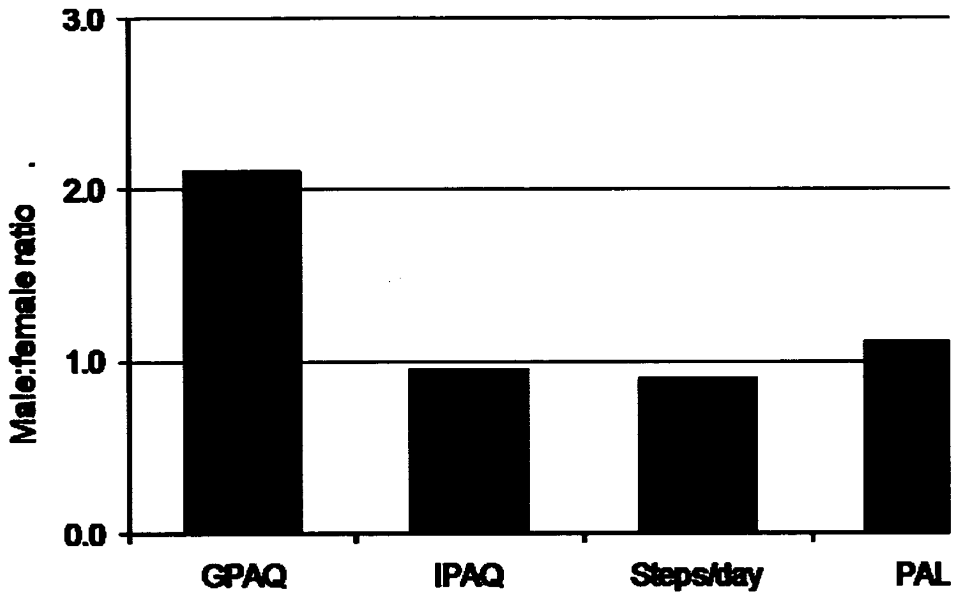

Figure 3.4: Male:female ratio of total physical activity recorded by the Global Physical Activity Questionnaire (GPAQ), the International Physical Activity Questionnaire (IPAQ), steps per day recorded by pedometer, and a physical activity record (PAR) of daily activities. Ratios were calculated using the median of each measure in steps per day for the pedometer measure and in MET-hours per week for other measures.

of work and domestic activities, were similar for the two groups (stable work patterns r = 0.20, unstable work patterns r = 0.34) but lower than the GPAQ test-retest correlations for the group with stable work patterns.

Further investigation revealed that participants who reported more work activity at the second administration of IPAQ than at the first administration tended to report less domestic activity, whilst those who reported less work activity on the second occasion tended to report more domestic activity (data not shown).

For physical activity in the transport domain, the GPAQ reliability coefficient (r = 0.25) was lower than that of the IPAQ (r = 0.60). To investigate this finding further, we examined modes of transport used (the IPAQ allowed us to do this because it records information on each mode of transport separately). From this, we identified a sizeable group consisting of 49% (58/119) of men and 56% (67/117) of women who used the same mode of transport (either walking or cycling) during each IPAQ reference period. These participants gave consistent accounts on the two occasions the questionnaire was administered, resulting in very high IPAQ reliability coefficients (correlations near unity). In contrast, this same group produced modest reliability coefficients for GPAQ.

Table 3.3: Test-retest correlations of physical activity by GPAQ and IPAQ repeated after three weeks.

	Men		Women	
	GPAQ	IPAQ	GPAQ	IPAQ
	r* (Num)	r* (Num)	r* (Num)	r* (Num)
Total physical activity†	0.32 (120)	0.34 (115)	0.13 (118)	0.20 (114)
Stable work pattern	0.36 (95)	0.35 (90)	0.31 (51)	0.25 (50)
Unstable work pattern	-0.08 (25)	0.19 (25)	-0.04 (67)	0.16 (64)
By domain†				
Work	- -	0.29 (120)	- -	0.26 (118)
Domestic	- -	0.22 (119)	- -	0.20 (117)
Work + domestic‡	0.36 (120)	0.31 (118)	0.17 (119)	0.13 (116)
Stable work	0.40 (95)	0.29 (93)	0.46 (52)	0.17 (51)
Unstable work	-0.01 (25)	0.30 (25)	-0.06 (67)	0.12 (65)
Transport	0.28 (121)	0.60 (119)	0.22 (121)	0.55 (117)
Same mode§	0.23 (58)	0.98 (58)	0.23 (67)	0.94 (67)
Different mode§	0.31 (61)	0.29 (61)	0.19 (50)	0.09 (50)
Leisure	0.18 (121)	0.43 (121)	0.24 (120)	0.44 (119)
No activity at all	1.00 (79)	1.00 (52)	1.00 (98)	1.00 (73)
Some activity	-0.41 (42)	0.05 (69)	-0.45 (22)	-0.09 (46)
Sitting time last 7 days				
Typical day	0.20 (121)		0.31 (120)	
Usual week day		0.32 (121)		0.49 (119)
Usual weekend day		0.15 (121)		0.43 (119)

*Spearman correlation coefficient.
†Metabolic Equivalent Task (MET) units in hours per week.
‡ Work activity by GPAQ and sum of work and domestic activity by IPAQ.
§ Based on IPAQ reports of whether or not the participant used the same mode of transport on both occasions.

The reliability of GPAQ (r = 0.21) was also poorer than that of IPAQ (r = 0.45) for leisure physical activity. Higher proportions of participants, particularly women, reported no leisure physical activity at both administrations of GPAQ compared with both administrations of IPAQ. Among those who reported some leisure physical activity, the majority (34 men and 18 women) reported no leisure physical activity at one administration of GPAQ and a high level of leisure physical activity at the other administration of GPAQ, resulting in negative GPAQ reliability coefficients. In additional analysis, there were no significant differences in terms of age, number of years attending school, and household income between the two groups of participants with stable and unstable work patterns (data not shown).

The associations between GPAQ, IPAQ, steps per day, and PAR MET-hours per week are shown in Table 3.4. The associations with GPAQ were markedly stronger for those with stable work patterns. For men and women with stable work patterns, the correlations of GPAQ with other physical activity measures were r = 0.32, r = 0.39, and r = 0.31 for IPAQ, steps per days and the PAR, respectively. For all men, the correlations of GPAQ with other physical activity measures were r = 0.39, r = 0.38, and r = 0.49 for IPAQ, steps per day, and the PAR, respectively. The corresponding correlations for women were r = 0.18, r = 0.25 and r = – 0.05, respectively.

Table 3.4: Correlations between four measures of total physical activity.

	GPAQ1*		IPAQ1†
	Stable	Unstable	
	r‡ (Num)	r‡ (Num)	r‡ (Num)
Men			
IPAQ1§	0.32 (95)	0.37 (26)	- -
GPAQ1§	- -	- -	0.34 (121)
Steps/day	0.42 (80)	0.22 (21)	0.16 (98)
PAR (MET≥3)§‖	0.51 (95)	0.19 (26)	0.53 (119)
Women			
IPAQ1§	0.41 (51)	-0.01 (67)	- -
GPAQ1§	- -	- -	0.21 (121)
Steps/day	0.33 (46)	0.16 (70)	0.30 (117)
PAR (MET≥3)§‖	-0.03 (53)	-0.08 (71)	0.14 (122)

* The first administration of the Global Physical Activity Questionnaire.
† The first administration of the International Physical Activity Questionnaire.
‡ Spearman correlation coefficient.
§ Metabolic Equivalent Task (MET) units in hours per week.
‖ Physical activity record for moderate and vigorous activities.

In additional analyses, we examined associations with cardiovascular risk indicators (blood pressure, cholesterol, glucose, indices of body fatness) and found the correlations were modest and generally similar for GPAQ and IPAQ, and less than those for steps per day and the PAR. These results are presented in Appendix 3A.

3.5 Discussion

GPAQ, with its changed definition of the work domain and a typical week as the reference period, was proposed as an improvement on IPAQ for use in developing countries (82). The reliability and validity of the two questionnaires were assessed in this study.

Regarding the re-definition of the work domain, we found that activity in the work domain (GPAQ) and activity in the work and domestic domains (IPAQ) accounted for similarly large proportions, more than 80%, of total physical activity measured by each instrument. However, MET-weighted hours of work measured by GPAQ were less than the sum of MET-weighted hours of work and domestic activities measured by IPAQ. Activity in the domestic domain of IPAQ was a substantial contributor to hours of total physical activity among men, and the principal contributor for women. By not seeking information about domestic activities separately, GPAQ may have underestimated total physical activity. For men, our data are not conclusive because an alternative explanation of the difference in GPAQ and IPAQ estimates is that the IPAQ over-estimates participation in some forms of activity as has been reported by others (80). For women, the case that GPAQ underestimates total physical activity appears stronger because their total physical activity was only half that of men when measured by GPAQ but almost identical when measured by three other instruments.

The test- retest correlations of measurements of work activity by GPAQ was different for those with stable and unstable work patterns, but those measurements of work and domestic activities by IPAQ were very similar. This is probably because the reference period for IPAQ is the last seven days, and the gap between measurements was too short (three weeks) to allow transition between stable and unstable work patterns based on seasonal changes. By contrast, GPAQ refers to the last 12 months.

With respect to the substitution of a typical week as the reference period, three study findings suggest that participants had difficulty with the concept of a typical week. Firstly, test-retest reliability coefficients for GPAQ estimates of work physical activity were moderate for subjects with stable work patterns and poor for those with unstable work patterns, suggesting that participants with variable work activities were unable to report consistently on their physical activity in a typical week. In contrast, despite referring to two different past week reference periods, the IPAQ reliability coefficients were more similar for these two groups. Secondly, the strong tendency for persons with unstable work patterns to report more physical activity on the second administration of GPAQ if they also reported more physical activity on the second administration of IPAQ suggests these people tend to be influenced by their recent activities when reporting activity in a typical week. Thirdly, reports of transport and leisure physical activity in the past week by IPAQ were more consistent than reports of these activities in a typical week by GPAQ.

The concurrent validity of GPAQ measurement was moderate for those with stable work patterns, and generally poor for those with unstable work patterns. For men with stable work patterns, the correlation of GPAQ with the three comparison measures (IPAQ, pedometer and PAR) were in the range of 0.30 to 0.50. For women, however, the GPAQ measurements were not correlated with the PAR. GPAQ focused on moderate and vigorous activities undertaken for at least 10 minutes at a time whereas the PAR allowed participants to record any activity even of short duration and the women in this sample often reported activities of less than 10 minutes in duration. The validity of GPAQ for participants across all work patterns was not superior to that of IPAQ.

The distinguishing difference between groups with stable and unstable work patterns appears to lie solely in their different patterns of physical activity. We could not find differences in factors such as age, education, or income that characterised the two groups.

There are two main differences between our findings and those of previous studies. We found that IPAQ had generally moderate reliability and concurrent validity while other studies have reported more favourable results. Findings from the 12-country testing of IPAQ (77), and from a study conducted on a representative sample from China (78), have both shown high reliability (correlations 0.80 and 0.81-0.89, respectively) and moderate associations (correlations 0.30 and 0.33, respectively) between IPAQ and objective measures of physical activity. Secondly, we found that substitution of "typical week" for "last seven days" appears to have had detrimental impacts on the reliability and validity of measurements of physical activity by GPAQ. In contrast, Craig et al (77) investigated "usual week" and "last seven days" reference periods in IPAQ measurements performed in 12 countries, and found no particular advantage for either. There are two possible reasons for the different findings of previous studies and this study. One reason is that their sample involved mostly volunteer participants from urban settings whilst our sample was population-based and dominated by farmers. Craig et al pointed out that IPAQ did not perform well in their rural sub-sample (reliability coefficients 0.25-0.32) (77), which might be more similar to our own. We did examine our data for this urban-rural difference but we found the difference was driven by the work pattern of participants. Another reason is that the time interval between the two administrations of IPAQ was 7 days in the Chinese study (78), 7 to 10 days in the 12-country testing study (77), and 3 weeks in our study. The longer time interval may have contributed to the lower reliability found for IPAQ in our study.

A strength of this study is that it was based on a representative sample of the local population that was recruited with a high response rate. None of the other studies were population-based. Selection bias is unlikely to be a major problem in this study, therefore, and the range and quantum of physical activity that was surveyed should be a good reflection of physical activity in the Vietnamese population. The use of WHO standardised protocols, the intensive training of data collection staff, the pre-study testing of procedures in a pilot study, and the close supervision of staff during data collection, all highlight the attention that was paid to minimising avoidable sources of measurement error. The use of questionnaires, pedometer and PAR provided a range of physical activity measures that were sufficiently varied to minimise the prospect of misleading associations due to correlated errors.

This study is subject to a number of limitations. Firstly, the usual caveats (96) regarding the assessment of comparative validity in the absence of a criterion standard apply here. Furthermore, as Masse (97) and Bauman et al (31) have pointed out, alternative methods of measuring physical activity such as those used in this study target different dimensions of physical activity and thus provide information that is related but different. Secondly, our results may not truly represent the reliability of IPAQ as a physical activity surveillance tool. On the one hand, we used the version of IPAQ intended for use in research (IPAQ-long) (34), which is more reliable (77), rather than the abbreviated version intended for use in population surveys (IPAQ-short). On the other hand, our results may underestimate the true reliability of IPAQ because the reference periods were two different 7 day periods. Thirdly, the definition of stable and unstable work patterns we used was based on reports of usual occupation in the last 12 months. These reports did not give us information directly on work activities performed in each occupation, and we needed to make assumptions regarding the variability of each occupation. Fourthly, because we needed to adhere to standardised WHO protocols, the GPAQ was always administered prior to IPAQ and the other measurements of physical activity. The possibility of order-of-administration effects cannot be excluded, therefore. The measurements of total activity by IPAQ was greater than those by GPAQ, and the earlier administration of GPAQ may have contributed to this by prompting more complete recall. Lastly, the administration of a PAR might have an effect on participants' recall of their activities at the second administration of the questionnaires. However, PARs have been shown to have no influence on the recall of physical activity (38).

In summary, the modifications made to IPAQ in the design of GPAQ may have improved the reliability of measurements of physical activity for persons with stable activity patterns, but that improved performance appears to have come at the expense of poorer reliability for those with more variable work patterns in this Vietnamese population. In addition, the modifications do not appear to have enhanced the moderate concurrent validity of IPAQ estimates of physical activity in this population. Future studies that utilise GPAQ should take into account this limitation. In our own work, we now allow participants who have more than one pattern of work to report their activities in each work pattern separately, together with the proportion of time spent on each pattern (i.e. number of months in a year).

3.7 Addendum

A revised version of GPAQ has recently been made available (82). It has minor modifications including removal of redundant screening questions and improved wording. The structure, reference period, and domains of the first version have been retained, however.

3.8 Postscript

The analyses of this chapter suggest that, overall, both GPAQ and IPAQ showed very modest reliability and validity in estimating physical activity in this population-based sample, highlighting the need to investigate the use of more objective methods to measure physical activity in the Vietnamese population. In the next chapter, I explore the feasibility of using pedometers to measure ambulatory physical activity in Vietnam, and assess the stability and validity of the measurement obtained. The study involved study participants (n = 250) wearing pedometers and recording their activities for seven consecutive days. The feasibility of pedometer use was assessed through the compliance of participants and the quality of data obtained. The stability of pedometer measurement was assessed using intraclass correlation coefficients (ICC). The concurrent validity of pedometer estimates was examined using its correlations with PAR estimates of physical activity.

Appendix 3A: Additional results on the reliability and validity of the Global Physical Activity Questionnaire (GPAQ) in Vietnam

3A.1 Introduction

This section presents the additional results on the reliability and validity of the Global Physical Activity Questionnaire (GPAQ) and the International Physical Activity Questionnaire (IPAQ) when measuring physical activity in the Vietnamese population. Details of the differences between the two questionnaires in respect of their wordings and question formats are provided and discussed. The associations between the four measures of physical activity – GPAQ, IPAQ, steps per day, and physical activity record (PAR) – and cardiovascular disease (CVD) risk indicators – body composition, blood pressure, blood glucose (BG) and total cholesterol (TC) – are compared. Because the physical activity measures were right skewed, partial Spearman correlation coefficients were used to summarise the associations between the physical activity measures and CVD risk indicators.

3A.2 Results

A comparison of wording between the GPAQ and IPAQ is presented in Table 3A.1. According to the WHO STEPwise approach to surveillance of risk factors for non-communicable diseases (STEPS) manual (http://www.who.int/chp/steps/manual/en/index.html), the translation of GPAQ utilises showcards and allows locally relevant terms to be inserted. In the showcards, local examples of moderate and vigorous activities are described in words and by pictures.

The IPAQ website (http://www.ipaq.ki.se/cultural.htm) also has a guideline for translation that suggests "cultural adaptation" of the questionnaire for local use. This guideline emphasises that the meaning of the survey is more important than the exact words when translating. The use of the Compendium of Physical Activity is recommended to identify moderate (MET = 3- 6) and vigorous (MET > 6) activities. Additionally, there are instructions on pilot testing of the translated IPAQ.

Table 3A.1: Comparisons of wording between GPAQ and IPAQ.

	GPAQ	IPAQ
Reference period	"in a typical week" "at least 10 minutes at a time"	"in the last seven days" "at least 10 minutes at a time"
Intensity	Vigorous: use showcard with relevant examples Moderate: use showcard with relevant examples	Vigorous: "make you breath much harder than normal" Moderate: "make you breath somewhat harder than normal" Walking
Question format	"In a typical week, how many days...?" "how much time do you spend ....on a typical day?"	"during the last seven day, how many days...?" "how much time did you usually spend on one of those days....?" Or "what is the total amount of time you spent over the last seven days .....?"
Domain		
Work	"things that you have to do such as paid or unpaid work, household chores, harvesting food, fishing or hunting or seeking employment"	"paid work, farming, volunteer work, course work and any other unpaid work that you did outside your home"
Domestic		"in and around your home, like housework, gardening, yard work, general maintenance work, and caring for family" - "in the garden or yard" - "inside the house" (moderate only)
Transport	"walking or cycling"	"travel in a motored vehicle" "ride a bicycle" "walk from place to place"
Leisure	"for recreation, fitness or sports [insert relevant terms]"	"solely for recreation, sport, exercise or leisure"
Sitting time	"over the last seven days, how much time did you spend sitting or reclining on a typical day?"	"during the last seven days, how much time did you usually spend sitting on a weekday?" "during ... on a weekend day?"

Correlations of predictive validity for the four measures of total physical activity with CVD risk indicators are presented in Table 3A.2. With some isolated exceptions, the correlations are poor and the measurements by GPAQ are not more predictive of these indicators than those by IPAQ. Restricting physical activity measures to vigorous intensity activity did not improve the correlations. Physical activity in the leisure domain predicted poorly the other health indicators with correlations around zero. Physical activity measures that had the best predictive validity were steps per day for men and PAR for women. Time spent sitting from both questionnaires was not more predictive of CVD risks than the time spent doing physical activity.

Table 3A.2: Correlations of the four measures of total physical activity and cardiovascular risk indicators*.

	GPAQ1†		IPAQ1‡	Steps/day	PAR
	Stable	Unstable			
	r§(Num)	r§(Num)	r§(Num)	r§(Num)	r§(Num)
Men¶					
BMI**	-0.18(98)	-0.06(26)	-0.05(121)	-0.21(101)	-0.10(121)
Waist	-0.19(98)	0.03(26)	-0.03(121)	-0.29(101)	-0.10(121)
WHR**	-0.08(98)	0.08(25)	0.04(120)	-0.28(101)	-0.10(120)
SBP**	0.06(96)	0.23(26)	0.08(119)	-0.06(99)	0.01(119)
BG**	-0.16(92)	0.11(23)	-0.18(112)	-0.24(94)	-0.18(113)
TC**	-0.20(92)	-0.35(23)	-0.17(112)	-0.29(94)	-0.20(113)
Women¶					
BMI**	0.07(54)	-0.10(71)	-0.02(123)	-0.06(121)	-0.10(126)
Waist	0.02(54)	-0.04(71)	-0.08(123)	-0.05(121)	-0.12(126)
WHR**	-0.05(54)	-0.05(71)	-0.13(123)	-0.04(121)	-0.11(126)
SBP**	-0.07(50)	-0.36(69)	-0.09(118)	-0.18(115)	-0.08(120)
BG**	0(53)	0.08(70)	0.05(121)	-0.05(119)	-0.05(124)
TC**	-0.17(53)	0.05(70)	-0.13(121)	-0.15(119)	-0.17(124)

* Measures by questionnaires and physical activity record (PAR) were in Metabolic Equivalent Task (MET) units in hours per week.
† The first administration of the Global Physical Activity Questionnaire.
‡ The first administration of the International Physical Activity Questionnaire.
§ Partial Spearman correlation coefficient
¶ Adjust for age.
** BMI body mass index, WHR waist to hip ratio, SBP systolic blood pressure, BG blood glucose, TC total cholesterol.

3A.3 Discussion

For both GPAQ and IPAQ, the strength of the associations of total physical activity with CVD risk indicators were similar and generally poor. The somewhat stronger associations found for alternative measurements of physical activity by pedometer (for men) and by PAR (for women) suggest that the questionnaires are subject to relatively high measurement error when applied in rural populations, and that the feasibility of using pedometers for cross-country comparisons of physical activity in developing countries should be more thoroughly investigated.

For men, the measurement s of physical activity by PAR were strongly correlated with measurements by GPAQ (particularly for those participants with stable work patterns) and by IPAQ, but each of these questionnaire-based measures performed poorly relative to the pedometer measurements in predicting CVD risk indicators. For women, possibly reflecting their more fragmented and low-intensity activity patterns, each of the measurements had modest predictive validity. Considering the complexity in obtaining PAR in contrast with having participants wearing pedometers and reporting steps, it may be more cost-effective for future researchers to focus on using pedometers to measure physical activity in the Vietnamese and similar populations

Appendix 3B: The International Physical Activity Questionnaire

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

(November 2002)

LONG LAST 7 DAYS TELEPHONE FORMAT

For use with Young and Middle-aged Adults (15-69 years)

The International Physical Activity Questionnaires (IPAQ) comprises a set of 4 questionnaires. Long (5 activity domains asked independently) and short (4 generic items) versions for use by either telephone or self-administered methods are available. The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health–related physical activity.

Background on IPAQ

The development of an international measure for physical activity started in Geneva in 1998 and was followed by extensive reliability and validity testing undertaken across 12 countries (14 sites) during 2000. The final results suggest that these measures have acceptable measurement properties for use in many settings and in different languages, and are suitable for national population-based prevalence studies of participation in physical activity.

Using IPAQ

Use of the IPAQ instruments for monitoring and research purposes is encouraged. It is recommended that no changes be made to the order or wording of the questions as this will affect the psychometric properties of the instruments.

Translation from English and Cultural Adaptation

Translation from English is encouraged to facilitate worldwide use of IPAQ. Information on the availability of IPAQ in different languages can be obtained at www.ipaq.ki.se. If a new translation is undertaken we highly recommend using the prescribed back translation methods available on the IPAQ website. If possible please consider making your translated version of IPAQ available to others by contributing it to the IPAQ website. Further details on translation and cultural adaptation can be downloaded from the website.

Data Entry and Coding

Attached to the response categories for each question are suggested variable names and valid ranges to assist in data management and interviewer training. We recommend that the actual response provided by each respondent is recorded. For example, "120 minutes" is recorded in the minutes response space. "Two hours" should be recorded as "2" in the hours column. A response of "one and a half hours" should be recorded as either "1" in hour column and "30" in minutes column.

Further Developments of IPAQ

International collaboration on IPAQ is on-going and an *International Physical Activity Prevalence Study* is in progress. For further information see the IPAQ website.

More Information

More detailed information on the IPAQ process and the research methods used in the development of IPAQ instruments is available at www.ipaq.ki.se and Booth, M.L. (2000). Assessment of Physical Activity: An International Perspective. Research Quarterly for Exercise and Sport, 71 (2): s114-20. Other scientific publications and presentations on the use of IPAQ are summarized on the website.

Long Last 7 Days Telephone IPAQ

READ: I am going to ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

PART 1: JOB-RELATED PHYSICAL ACTIVITY

READ: The first questions are about your work. This includes paid jobs, farming, volunteer work, course work and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. I will ask you about these later.

1. Do you currently have a job or do any unpaid work outside your home? [WORK; Yes=1, No=0; 8, 9]

    _____ Yes
    _____ No *[Skip to PART 2]*
    8. Don't Know/Not Sure *[Skip to PART 2]*
    9. Refused *[Skip to PART 2]*

    [Interviewer clarification: This also includes credit and non-credit classes or course work. It also includes volunteer work and time spent looking for work. It does not include unpaid house or yard work, nor caring for dependents, this will be asked in a later section.]

READ: The following questions are about all the physical activity you did as part of your paid or unpaid work. This does not include traveling to and from work.

READ: First, think about all the *vigorous* activities which take *hard physical effort* that you did as part of your work. Vigorous activities make you breathe much harder than normal. These may include things like heavy lifting, digging, heavy construction work, or climbing up stairs. Think about only those vigorous physical activities that you did for at least 10 minutes at a time.

2. During the last 7 days, on how many days did you do vigorous physical activities as part of your work? [OVDAY; Range 0-7, 8, 9]

    _____ Days per week *[If respondent answers 0, skip to Question 4]*
    8. Don't Know/Not Sure *[Skip to Question 4]*
    9. Refused *[Skip to Question 4]*

    [Interviewer clarification: Think about only those physical activities that you did for at least 10 minutes at a time.]

    [Interviewer clarification: Work includes paid and unpaid work as well as course work. Include all jobs and volunteer work.]

3. How much time did you usually spend on one of those days doing vigorous physical activities as part of your work?

    ___ ___ Hours per day [OVDHRS; Range 0-16]
    ___ ___ ___Minutes per day [OVDMIN; Range 0-960, 998, 999]
    998. Don't Know/Not Sure
    999. Refused

[Interviewer clarification: Think about only those physical activities you did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, or includes time spent doing a variety of paid and unpaid work, ask: "What is the total amount of time you spent over the last 7 days doing vigorous physical activities as part of your work?"

___ ___ Hours per week [OVWHRS; Range 0-112]
___ ___ ___ ___Minutes per week [OVWMIN; Range 0-6720, 9998, 9999]
9998. Don't Know/Not Sure
9999. Refused

READ: Now think about activities which take *moderate* physical effort that you did as part of you work. Moderate physical activities make you breathe somewhat harder than normal and may include activities like carrying light loads. Do not include walking. Again, think about only those moderate physical activities that you did for at least 10 minutes at a time.

4. During the last 7 days, on how many days did you do moderate physical activities as part of your work? [OMDAY; Range 0-7, 8, 9]
_____ Days per week *[If respondent answers 0, skip to Question 6]*
8. Don't Know/Not Sure *[Skip to Question 6]*
9. Refused *[Skip to Question 6]*

[Interviewer clarification: Think about only those physical activities that you did for at least 10 minutes at a time.]

[Interviewer clarification: Work includes paid and unpaid work as well as course work. Include all jobs.]

5. How much time did you usually spend on one of those days doing moderate physical activities as part of your work?
___ ___ Hours per day [OMDHRS; Range 0-16]
___ ___ ___Minutes per day [OMDMIN; Range 0-960, 998, 999]
998. Don't Know/Not Sure
999. Refused

[Interviewer clarification: Think about only those physical activities you did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, or includes time spent doing a variety of paid and unpaid work, ask: "What is the total amount of time you spent over the last 7 days doing moderate physical activities as part of your work?"

___ ___ Hours per week [OMWHRS; Range 0-112]
___ ___ ___ ___Minutes per week [OMWMIN; Range 0-6720, 9998, 9999]
9998. Don't Know/Not Sure
9999. Refused

READ: Now think about the time you spend *walking* for at least 10 minutes at a time as part of your work. Please do not count any walking you did to travel to or from work.

6. During the last 7 days, on how many days did you walk as part of your work? [OWDAY; Range 0-7, 8, 9]

_____ Days per week *[If respondent answers 0, skip to PART 2]*
8. Don't Know/Not Sure *[Skip to PART 2]*
9. Refused *[Skip to PART 2]*

[Interviewer clarification: Think about only the walking that you did for at least 10 minutes at a time.]

[Interviewer clarification: Include all jobs.]

7. How much time did you usually spend on one of those days walking as part of your work?

___ ___ Hours per day [OWDHRS; Range 0-16]
___ ___ ___Minutes per day [OWDMIN; Range 0-960, 998, 999]
998. Don't Know/Not Sure
999. Refused

[Interviewer clarification: Think about only the walking you did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, or includes time spent doing a variety of paid and unpaid work, ask: "What is the total amount of time you spent walking over the last 7 days as part of your work?"

___ ___ Hours per week [OWWHRS; Range 0-112]
___ ___ ___ ___Minutes per week [OWWMIN; Range 0-6720, 9998, 9999]
9998. Don't Know/Not Sure
9999. Refused

PART 2: TRANSPORTATION PHYSICAL ACTIVITY

READ: Now, think about how you traveled from place to place, including to places like work, stores, movies and so on.

8. During the last 7 days, on how many days did you travel in a motor vehicle like a train, bus, car or tram? [TMDAY; Range 0-7, 8, 9]

_____ Days per week *[If respondent answer 0, skip to Question 10]*
8. Don't Know/Not Sure *[Skip to Question 10]*
9. Refused *[Skip to Question 10]*

9. How much time did you usually spend on one of those days traveling in a car, bus, train or other kind of motor vehicle?

___ ___ Hours per day [TMDHRS; Range 0-16]
___ ___ ___Minutes per day [TMDMIN; Range 0-960, 998, 999]
998. Don't Know/Not Sure

999. Refused

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent over the last 7 days traveling in a motor vehicle?"

___ ___ Hours per week [TMWHRS; Range 0-112]

___ ___ ___ ___Minutes per week [TMWMIN; Range 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think only about the *bicycling* you did to travel to and from work, to do errands, or to go from place to place. Only include bicycling that you did for at least 10 minutes at a time.

10. During the last 7 days, on how many days did you bicycle to go from place to place? [TBDAY; Range 0-7, 8, 9]

_____ Days per week *[If respondent answers 0, skip to Question 12]*

8. Don't Know/Not Sure *[Skip to Question 12]*

9. Refused *[Skip to Question 12]*

[Interviewer clarification: Think only about the bicycling that you did for at least 10 minutes at a time.]

11. How much time did you usually spend on one of those days to bicycle from place to place?

___ ___ Hours per day [TBDHRS; Range 0-16]

___ ___ ___Minutes per day [TBDMIN; Range 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[Interviewer clarification: Think about only the bicycling that you did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent bicycling over the last 7 days to travel from place to place?"

___ ___ Hours per week [TBWHRS; Range 0-112]

___ ___ ___ ___Minutes per week [TBWMIN; Range 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think only about the *walking* you did to travel to and from work, to do errands or to go from place to place. Only include walking that you did for at least 10 minutes at a time.

12. During the last 7 days, on how many days did you walk to go from place to place?
[TWDAY; Range 0-7, 8, 9]

_____ Days per week *[If respondent answers 0, skip to PART 3]*

8. Don't Know/Not Sure *[Skip to PART 3]*

9. Refused *[Skip to PART 3]*

[Interviewer clarification: Think only about the walking that you did for at least 10 minutes at a time.]

13. How much time did you usually spend on one of those days walking from place to place?

___ ___ Hours per day [TWDHRS; Range 0-16]

___ ___ ___Minutes per day [TWDMIN; Range 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[Interviewer clarification: Think about only the walking that you did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent over the last 7 days walking from place to place?"

___ ___ Hours per week [TWWHRS; Range 0-112]

___ ___ ___ ___Minutes per week [TWWMIN; Range 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

PART 3: HOUSEWORK, HOUSE MAINTENANCE AND CARING FOR FAMILY

READ: Now think about the physical activities you have done in the last 7 days in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

READ: First think about *vigorous* activities which take hard physical effort that you did in the garden or yard. Vigorous activities make you breathe much harder than normal and may include heavy lifting, chopping wood, shoveling snow, or digging. Again, think about only those vigorous physical activities that you did for at least 10 minutes at a time.

14. During the last 7 days, on how many days did you do vigorous physical activities in the garden or yard? [GVDAY; Range 0-7, 8, 9]

_____ Days per week *[If respondent answers 0, skip to Question 16]*

8. Don't Know/Not Sure *[Skip to Question 16]*

9. Refused *[Skip to Question 16]*

[Interviewer clarification: Think about only those physical activities that you did for at least 10 minutes at a time.]

15. How much time did you usually spend on one of those days doing vigorous physical activities in the garden or yard?

___ ___ Hours per day [GVDHRS; Range 0-16]

___ ___ ___Minutes per day [GVDMIN; Range 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[Interviewer clarification: Think about only those physical activities that you did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent over the last 7 days doing vigorous physical activities in the garden or yard?"

___ ___ Hours per week [GVWHRS; Range 0-112]

___ ___ ___ ___Minutes per week [GVWMIN; Range 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think about activities which take *moderate* physical effort that you did in the garden or yard. Moderate physical activities make you breathe somewhat harder than normal and may include carrying light loads, sweeping, washing windows, and raking. Again, include only those moderate physical activities that you did for at least 10 minutes at a time.

16. During the last 7 days, on how many days did you do moderate activities in the garden or yard? [GMDAY; Range 0-7, 8, 9]

_____ Days per week *[If respondent answers 0, skip to Question 18]*

8. Don't Know/Not Sure *[Skip to Question 18]*

9. Refused *[Skip to Question 18]*

[Interviewer clarification: Think about only those physical activities that you did for at least 10 minutes at a time.]

17. How much time did you usually spend on one of those days doing moderate physical activities in the garden or yard?

___ ___ Hours per day [GMDHRS; Range 0-16]

___ ___ ___Minutes per day [GMDMIN; Range 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[Interviewer clarification: Think about only those physical activities that you did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent over the last 7 days doing moderate physical activities in the garden or yard?"

___ ___ Hours per week [GMWHRS; Range 0-112]

___ ___ ___ ___Minutes per week [GMWMIN; Range 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think about activities which take at least *moderate* physical effort that you did *inside your home.* Examples include carrying light loads, washing windows, scrubbing floors, and sweeping. Include only those moderate physical activities that you did for at least 10 minutes at a time.

[Interviewer clarification: Moderate activities make you breathe somewhat harder than normal.]

18. During the last 7 days, on how many days did you do moderate activities inside your home? [HMDAY; Range 0-7, 8, 9]

_____ Days per week *[If respondent answers 0, skip to PART 4]*

8. Don't Know/Not Sure *[Skip to PART 4]*

9. Refused *[Skip to PART 4]*

[Interviewer clarification: Think about only those physical activities that you did for at least 10 minutes at a time.]

[Interviewer clarification: During the last 7 days, on how many days did you do activities that take at least moderate effort inside your home?]

19. How much time did you usually spend on one of those days doing moderate physical activities inside your home?

___ ___ Hours per day [HMDHRS; Range 0-16]

___ ___ ___Minutes per day [HMDMIN; Range 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[Interviewer clarification: Think about only those physical activities that you did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent over the last 7 days doing moderate physical activities inside your home?"

___ ___ Hours per week [HMWHRS; Range 0-112]

___ ___ ___ ___Minutes per week [HMWMIN; Range 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVIITY

READ: Now, think about all the physical activities that you did in the last 7 days solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the last 7 days, on how many days did you walk for at least 10 minutes at a time in your leisure time?

[LWDAY; Range 0-7, 8, 9]

_____ Days per week *[If respondent answers 0, skip to Question 22]*

8. Don't Know/Not Sure *[Skip to Question 22]*

9. Refused *[Skip to Question 22]*

[Interviewer clarification: Think about only the walking that you did for at least 10 minutes at a time.]

21. How much time did you usually spend on one of those days walking in your leisure time?

___ ___ Hours per day [LWDHRS; Range 0-16]

___ ___ ___Minutes per day [LWDMIN; Range 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[Interviewer clarification: Think about only the walking that you did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent over the last 7 days walking in your leisure time?"

___ ___ Hours per week [LWWHRS; Range 0-112]

___ ___ ___ ___Minutes per week [LWWMIN; Range 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think about other physical activities you did in your leisure time for at least 10 minutes at a time.

READ: First, think about *vigorous* activities which take hard physical effort that you did in your leisure time. Examples include aerobics, running, fast bicycling, or fast swimming.

[Interviewer clarification: Vigorous activities make you breathe much harder than normal.]

22. During the last 7 days, on how many days did you do vigorous physical activities in your leisure time? [LVDAY; Range 0-7, 8, 9]

_____ Days per week *[If respondent answers 0, skip to Question 24]*

8. Don't Know/Not Sure *[Skip to Question 24]*

9. Refused *[Skip to Question 24]*

[Interviewer clarification: Think about only those vigorous physical activities that you did for at least 10 minutes at a time.]

23. How much time did you usually spend on one of those days doing vigorous physical activities in your leisure time?

___ ___ Hours per day [LVDHRS; Range 0-16]

___ ___ ___Minutes per day [LVDMIN; Range 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[Interviewer clarification: Think about only those physical activities that you did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent over the last 7 days doing vigorous physical activities in your leisure time?"

___ ___ Hours per week [LVWHRS; Range 0-112]

___ ___ ___ ___Minutes per week [LVWMIN; Range 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think about activities which take *moderate* physical effort that you did in your leisure time. Examples include bicycling at a regular pace, swimming at a regular pace, and doubles tennis. Again, include only those moderate activities that you did for at least 10 minutes at a time.

[Interviewer clarification: Moderate physical activities make you breathe somewhat harder than normal.]

24. During the last 7 days, on how many days did you do moderate physical activities in your leisure time? [LMDAY; Range 0-7, 8, 9]

_____ Days per week *[If respondent answers 0, skip to PART 5]*

8. Don't Know/Not Sure *[Skip to PART 5]*

9. Refused *[Skip to PART 5]*

[Interviewer clarification: Think about only those physical activities that you did for at least 10 minutes at a time.]

23. How much time did you usually spend on one of those days doing moderate physical activities in your leisure time?

___ ___ Hours per day [LMDHRS; Range 0-16]

___ ___ ___Minutes per day [LMDMIN; Range 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[Interviewer clarification: Think about only those physical activities that you did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent over the last 7 days doing moderate physical activities in your leisure time?"

___ ___ Hours per week [LMWHRS; Range 0-112]

___ ___ ___ ___Minutes per week [LMWMIN; Range 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

PART 5: TIME SPENT SITTING

READ: The last question is about the time that you spent *sitting* during the last 7 days. Include time at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the last 7 days, how much time did you usually spend sitting on a weekday?

___ ___ Hours per day [SDHRS; Range 0-16]
___ ___ ___Minutes per day [SDMIN; Range 0-960, 998, 999]
998. Don't Know/Not Sure
999. Refused

[Interviewer clarification: Include time spent lying down (awake) as well as sitting.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent sitting varies widely from day to day, ask: "How much time in total did you spend sitting on Wednesday?"
___ ___ Hours on Wednesday [SWHRS; Range 0-16]
___ ___ ___ ___Minutes per Wednesday [SWMIN; Range 0-960, 998, 999]
9998. Don't Know/Not Sure
9999. Refused

27. During the last 7 days, how much time did you usually spend sitting on a weekend day?
___ ___ Hours per day [SEHRS; Range 0-16]
___ ___ ___Minutes per day [SEMIN; Range 0-960, 998, 999]
998. Don't Know/Not Sure
999. Refused

[Interviewer clarification: Include time spent lying down (awake) as well as sitting.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent sitting varies widely from day to day, ask: "How much time in total did you spend sitting on Saturday?"
___ ___ Hours on Saturday [SSHRS; Range 0-16]
___ ___ ___ ___Minutes per Saturday [SSMIN; Range 0-960, 998, 999]
9998. Don't Know/Not Sure
9999. Refused

Chapter 4: Using pedometers to estimate ambulatory physical activity in Vietnam.

4.1 Preface

The previous chapter provided an assessment of the reliability and validity of the Global Physical Activity Questionnaire (GPAQ), the physical activity questionnaire used in the "STEPwise approach to surveillance of risk factors for non-communicable diseases" (STEPS) methodology. It was shown that GPAQ had modest reliability and validity, and that this was true also for the International Physical Activity Questionnaire (IPAQ) – the other main questionnaire used in international comparisons of population level of physical activity.

In this chapter I investigate the use of pedometers for measuring ambulatory physical activity in the Vietnamese population. The material presented here has been published in a peer-reviewed journal (57). Additional analyses are reported in Appendix 4A. The instructions for using pedometers and recording activities in a physical activity record (PAR) whilst wearing the pedometer are reproduced in Appendix 4B. Some common problems encountered in processing data from PARs are reported in Appendix 4C, and the approaches used to deal with them are noted. The MET values assigned to common activities are reported in Appendix 4D.

4.2 Introduction

Physical inactivity, which has increased in prevalence in Vietnam in recent times (26, 55), is likely to be an important contributor to the growing burden of non-communicable disease (NCD) in the country (98). However, these reports are based on questionnaire measurements of physical activity. This method of measurement is subject to limitations including misclassification, recall bias, and floor effects (e.g. activities that have intensity lower than brisk walking or have duration less than 10 minutes are not counted) (29). An alternative approach is to measure physical activity by an objective method such as pedometers. Pedometers are increasingly being used to measure physical activity at the population level due to their ease of use, relatively low cost, and acceptable reliability and validity (42, 45, 99). To date, pedometers have been successfully used in population studies in Switzerland (39), the United States (US) (100, 101), Australia (35), and Brazil (102) with pedometer wear period varying from one to seven days. These studies suggest that it is feasible to use pedometers for large scale, population-based surveys under varying conditions in different countries. However, there are still some questions about their applicability for use in all parts of the world. In Vietnam, challenges include a higher prevalence of work activities involving contact with water, bumpy road conditions that can cause pedometers to erroneously register "steps" for those travelling by motor-vehicle, clothing with soft waist bands that may influence the accuracy of pedometer recording, and an uneven level of literacy that may impact on the ability of participants to accurately complete the pedometer diary. In addition, pedometers do not measure upper body movements and other non-ambulatory activities that contribute to total physical activity. The significance of these activities in the Vietnamese population is unknown.

This study assessed the feasibility of using pedometers to measure physical activity levels in a Vietnamese population and examined the stability and validity of the estimates obtained.

4.3 Methods

Sample

This study utilised a sub-sample of eligible subjects from a population survey of 25-64 year old residents of Can Tho, Vietnam. The survey used the STEPS methodology developed by the World Health Organization for use in member countries. The survey involved n=1978 participants selected by stratified multi-stage sampling. Details of the survey have been reported in Chapter 2 and have been published (55).

Subjects in the sub-sample were selected as follows. Three rural and three urban communes from the eight rural and eight urban communes surveyed were selected by simple random sampling. When eligible residents of these communes were selected to participate in the survey, every third eligible subject (325 in total) was selected by systematic random sampling to participate in this study. Of them, 77.2% (251/325) participated in the survey and 99.6% (250/251) of them participated in this study. Characteristics of the participants in this sub-sample have been described in Chapter 3.

Informed consent was obtained from participants. Those who could not sign the consent form provided verbal consent. The Ethics Committee of Can Tho University of Medicine and Pharmacy approved the study. Data collection occurred from July to December 2005.

Measurements

Each participant wore a pedometer for seven consecutive days following the STEPS survey clinic and recorded steps and pedometer wear details in a pedometer diary. Participants also recorded their activities for each pedometer day in a PAR.

In Vietnam, health volunteers (also called village health workers) are responsible for delivering basic health services such as contraceptives, vaccination reminders, and monitoring adherence to prescribed medication regimes for persons living in an assigned local area of their neighbourhood (103). The health volunteers maintain and regularly update a list of the persons in their assigned area. In the STEPS survey, persons were selected at the final stage of sampling from these lists. In this study, the health volunteers assisted with the recruitment and data collection process. Their role included visiting and inviting eligible subjects to come to the study clinic, reminding participants to wear their pedometers, helping them to fill in the PAR if needed, acting as contact person for the researcher and participants, collecting the pedometer diary and PAR on completion, and distributing small gifts to participants when they had finished their pedometer recordings. The health volunteers received payment for their work in this study.

Yamax pedometers (models SW 200 and SW 700) were used. They have been shown to have the greatest reliability and validity of the commercially available pedometers (45, 104-106). The pedometers were checked before and after each use by a research assistant. The test involved wearing the pedometer on the waist, walking for exactly 100 steps. Pedometers were removed from use if the reading recorded was 5% lower or 5% higher than the actual steps taken. At the clinic, participants were instructed to wear their pedometers fastened to their belt or waistband on the right mid-axillary line of their waist. The pedometers were required to be reset each morning after recording the previous day's steps in the diary. Participants were also asked to seek assistance from the health volunteers or the researcher if they encountered any problem. Participants who required special help (e.g. to fill in the diary) were identified and their health volunteers were informed at the time of the clinic.

Instructions for pedometer wear, the pedometer diary and PAR were integrated into one document (see Appendix 4B) based on the format of the logbook used in the Burnie Take Heart Project (35). The pedometer diary consisted of paper copy with columns for date, start time, stop time, and number of steps recorded. Participants were asked also to report the total amount of time spent riding on a motorbike or sitting on the back of a bicycle (behind another person who operated the pedals), travelling by bus on a bumpy road, and periods of time spent without the pedometer during the day (e.g. when working in water). In the PAR, participants reported each activity performed including those activities undertaken whilst not wearing the pedometer. They were required to record the period of time, a short description of the activity, and the intensity (low, moderate or vigorous) of the activity. There was space for participants to add comments. Two example pages with common patterns of activities were included in the instructions.

Statistical methods

Pedometer diaries and PARs were examined for their completeness, comprehensiveness, and consistency (see Appendix 4C). Each activity reported in the PAR was assigned the Metabolic Equivalent Task (MET) intensity of the most similar activity listed in the Compendium of Physical Activities (107) (see Appendix 4D). The MET intensity of an activity is the ratio of the metabolic rate of energy expenditure per kilogram per hour whilst undertaking the activity relative to a standard resting metabolic rate. The metabolic cost of each listed activity was obtained by multiplying the activity duration by its MET intensity. These were summed across all activities to calculate total MET-weighted hours of activities.

Pedometer data checking involved logical checks to identify implausible values, and outlier labelling using the Tukey method (108). Implausible values and outliers were cross-checked with the hard copy and corrected if a data entry error had occurred. Standardised residuals from the linear regression were then used to evaluate whether the outliers explained other indicators such as body mass index (BMI), waist, and waist to hip ratio of the participants. The dfbeta influence measure (109) was used to evaluate the influence of these values on the model. Influential cases were identified as having dfbeta exceeding $\frac{2}{\sqrt{n}}$ (109). These values were then excluded from the analysis. Appropriate transformations were used to remove skewness of data.

Assessment of the stability of the pedometer measurement included investigation of: how many hours per day to measure, which days of the week to measure, and how many days to measure. To examine whether there is a critical number of hours the pedometer should be worn in a day, we regressed steps recorded per day on hours worn allowing a change of slope and used a non-linear algorithm to estimate the vertical ordinate at which the slope changes (the knot). The average steps for each day of the week and all seven days were used to examine the difference in number of steps on weekdays and weekend days. This was done for urban and rural participants separately because urban participants were more likely to have office work, which may result in weekday and weekend differences in terms of physical activity. The number of measurement days required was assessed by estimating the mean and standard deviation (SD) of average steps per day and by calculating intraclass correlation coefficients (ICC). The formula used for the ICC of a mean of k ratings (110) is denoted as ICC(1,k).

$$ICC(1,k) = \frac{BMS - WMS}{BMS}$$

In which: BMS was between subject mean square
WMS was within subject mean square
k was the number of measures

BMS and WMS were obtained from the one-way analysis of variance (ANOVA). For comparison, we also calculated ICC for a single rating and denoted it as ICC(1,1).

$$ICC(1,1) = \frac{BMS - WMS}{BMS + (k-1)WMS}$$

In which: BMS was between subject mean square
WMS was within subject mean square
k was the number of measures

BMS and WMS were obtained from the one-way ANOVA.

Based on the results of the analyses of number of days needed (see Results), the validity analyses were restricted to participants who wore the pedometer for at least three days. Nine participants were excluded from these analyses.

Content validity was assessed by comparing average steps per hour for different groups of participants whose types of physical activity may influence pedometer readings. Groups whose occupations significantly influenced their pedometer readings were excluded from other validity analyses. Concurrent validity was assessed by the Spearman correlation coefficient between average steps per hour and average MET-hours per day of activity recorded by PAR. Predictive validity was examined by partial Spearman correlation coefficients between steps recorded and cardiovascular risk indicators adjusting for age and sex.

Qualitative methods

Qualitative methods were used to gain a greater understanding of pedometer use among this population. Informants were all 15 health volunteers, and 26 study participants selected by maximum variation, unique cases and opportunistic sampling techniques to cover the range and depth of variation in informant experiences. Semi-structured interviews, informal interviews, and review of pedometer diaries and the PAR were used. Data were recorded by field notes and notes taken during interviews. Triangulation of multiple sources of data was used to improve rigour of the findings. Data were analysed thematically using Nvivo 7.

4.4 Results

The participants in the subsample consisted of 123 men and 127 women of average age 45.9 (SD 10.3) years. Their characteristics have been presented in details in Chapter 3 and are summarised in Table 4.1. More than 50% of men and a third of women in this sample were farmers. In addition, one quarter of women were home-makers. In all these respects, the participants in the sub-sample were similar to the full sample of survey participants.

Feasibility of using pedometers

Six participants (2.4%) were found to be illiterate and many more needed some help from the health volunteers to record their activities. One or two participants at each site (6-12 in total) were wearing clothing with soft waistbands and were asked to change to clothing with a stiffer waistband when wearing the pedometers. Two participants altered the mode setting on their Yamax model SW700 pedometers, which resulted in unusable recordings. Two pedometers were lost and four others were damaged due to contact with water.

Other than six men whose occupation involved riding motorbikes, participants used motorbikes for only 20.1 (SD 51.6) minutes per day on average, and there was only a weak association ($r = 0.03$) between time spent on a motorbike and total steps recorded. The average time participants spent bicycle riding, as reported in the PAR, was 1.38 (SD 5.64) minutes per day.

Pedometer compliance and usage issues are presented in Table 4.1. The mean number of days of pedometer wear was 6.6 days. Overall, after removing unusable data, 97.6% (244/250) of participants provided at least one day of usable recording.

Findings from the qualitative study

The main qualitative finding was that wearing a pedometer was acceptable and most of the participants were compliant. Participants were willing to wear pedometers and many were proud to have a pedometer, with one stating that *"I said it was a tape recorder"*. They were enthusiastic and interested. For example, one commented when they were concerned about the readings. *"Today the pedometer counted only 2000 steps when I have been active all day, so I think it is not working. Even walking around the rice field for two hours is more steps than that"*.

However, some problems related to pedometer use were identified in the qualitative work. Key themes related to this were (1) Concerns about pedometers; (2) Activities that pedometers failed to capture; (3) The influence of health volunteers.
These problems were addressed during the data collection phase and thus had very little impact on the quality of data collected overall. However, they give insight into the process of pedometer research in Vietnam and highlight areas where other researchers conducting similar research will need to pay careful attention. These themes are discussed below.

Concerns about pedometers

Some participants found wearing a pedometer to be worrying and did not always comply with instructions. One man was reluctant to wear "*the machine*" because he thought it was for "*some experimental purpose for medical students*". A woman reported reducing the number of steps when her pedometer reading seemed unusually high, and stated that *"...the number on the machine kept going up. I was scared, thought I had a disease*". Another man stopped wearing his pedometer when he changed into shorts after work because he felt it "*looks awkward on the shorts*". A participant who worked at a fish market where she had to sit and bend over found that her pedometer *"annoyed me every time I bent down"*.

Activities that pedometers failed to capture

Instructions for pedometer wear did not always anticipate some of the situations described by participants. For example, some described trying to wear the pedometer on the back of their waistband or covering it in plastic to wear under water. Participants hesitated to wear pedometers if their activities were likely to involve unexpected contact with water, such as drying rice in the wet season when impromptu downfalls are common, and fishing. Participants reported removing pedometers in these situations. Others misunderstood instructions. For example, two participants described removing their pedometers when finishing work rather than at the end of the day, and others forgot to put on their pedometers in the morning. "*I have twin babies, when they wake me in the morning I have no time to think about the pedometer*".

The influence of health volunteers

Health volunteers occasionally influenced the data in the PAR and the pedometer diary. Participants with poor literacy required help with reading and writing and at times health volunteers also assisted participants to improve the completeness and thoroughness of the data. However, some participants reported that health volunteers had fabricated information to replace missing data. For example, one health volunteer took away a participant's pedometer after he accidentally immersed his pedometer in water on the third day *"he came to check the next day and was upset so he took everything back*". However, the record for this participant showed seven days of data and the first two days had different hand-writing to the later five days.

Health volunteers did not always understand the differences between fabricating data and recording the actual activities of the participant. For example a health volunteer showed the researcher an empty PAR and asked *"Can I just fill it in? I know very well what she does"*. Another health volunteer said that *"you can't just make it up by guessing, you need their first day to do that!"*

Stability of pedometer measurements

How many hours per day are needed?

The average wear time was 14.8 hours (SD 1.8) for men and 14.9 hours (SD 1.6) for women. Daily steps were significantly correlated with wear time ($r = 0.14$, $p<0.01$ for men, $r = 0.18$, $p<0.01$ for women). Steps increased with hours of wear for men, but plateaued at 14.4 (95% confidence interval 13.5-15.3) hours for women (Figure

4.1). There were 32% of daily recordings by women with less than 14.4 hours of wear time.

Table 4.1: Participants' characteristics and pedometer compliance and usage issues*

	Men		Women	
	%	(n/N)	%	(n/N)
Characteristics of participants				
Age, mean (SD)	46.2	(9.9)	45.7	(10.7)
Vietnamese ethnicity	95.9	(118/123)	91.3	(116/127)
Years of school, mean (SD)	7.0	(4.0)	4.4	(3.3)
Self-employed	70.7	(87/123)	55.1	(70/127)
Body mass index (kg/m^2), mean (SD)	20.9	(3.0)	21.6	(3.9)
Completeness of data obtained				
Pedometer diaries and PAR† completed	97.6	(120/123)	98.4	(125/127)
Pedometer diaries only	1.6	(2/123)	0.8	(1/127)
PAR† only	0.8	(1/123)	0	(1/127)
Pedometer recordings				
Participants without any unreliable data	79.7	(98/123)	85.0	(108/127)
Participants rode motorbike most of day	4.9	(6/123)	0	(0/127)
Participants worked in water most of day	6.5	(8/123)	0.8	(1/127)
Participants with some unreliable data‡	6.5	(8/123)	12.6	(16/127)
Participants without any reliable data‡	2.4	(3/123)	1.6	(2/127)
Number of days wearing pedometer				
0 day	0.8	(1/123)	0.0	(0/127)
1 day	0.0	(0/123)	0.0	(0/127)
2 days	1.6	(2/123)	1.6	(2/127)
3 days	1.6	(2/123)	0.8	(1/127)
4 days	3.3	(4/123)	3.2	(4/127)
5 days	6.5	(8/123)	0.8	(1/127)
6 days	7.3	(9/123)	11.0	(14/127)
7 days	78.9	(97/123)	82.7	(105/127)

* All results are presented in percentage (n/N) unless otherwise specified.
† Physical activity record
‡ The reliability of data was assessed based on logical checks and qualitative assessment.

Which days to measure?

There was no evidence of a consistent pattern of difference in steps per day across days of week in either urban or rural locations (Table 4.2). In additional analyses, we investigated the influence of day order (whether more steps were recorded on the first day of wear, for example) and again found no consistent differences (see Appendix 4A).

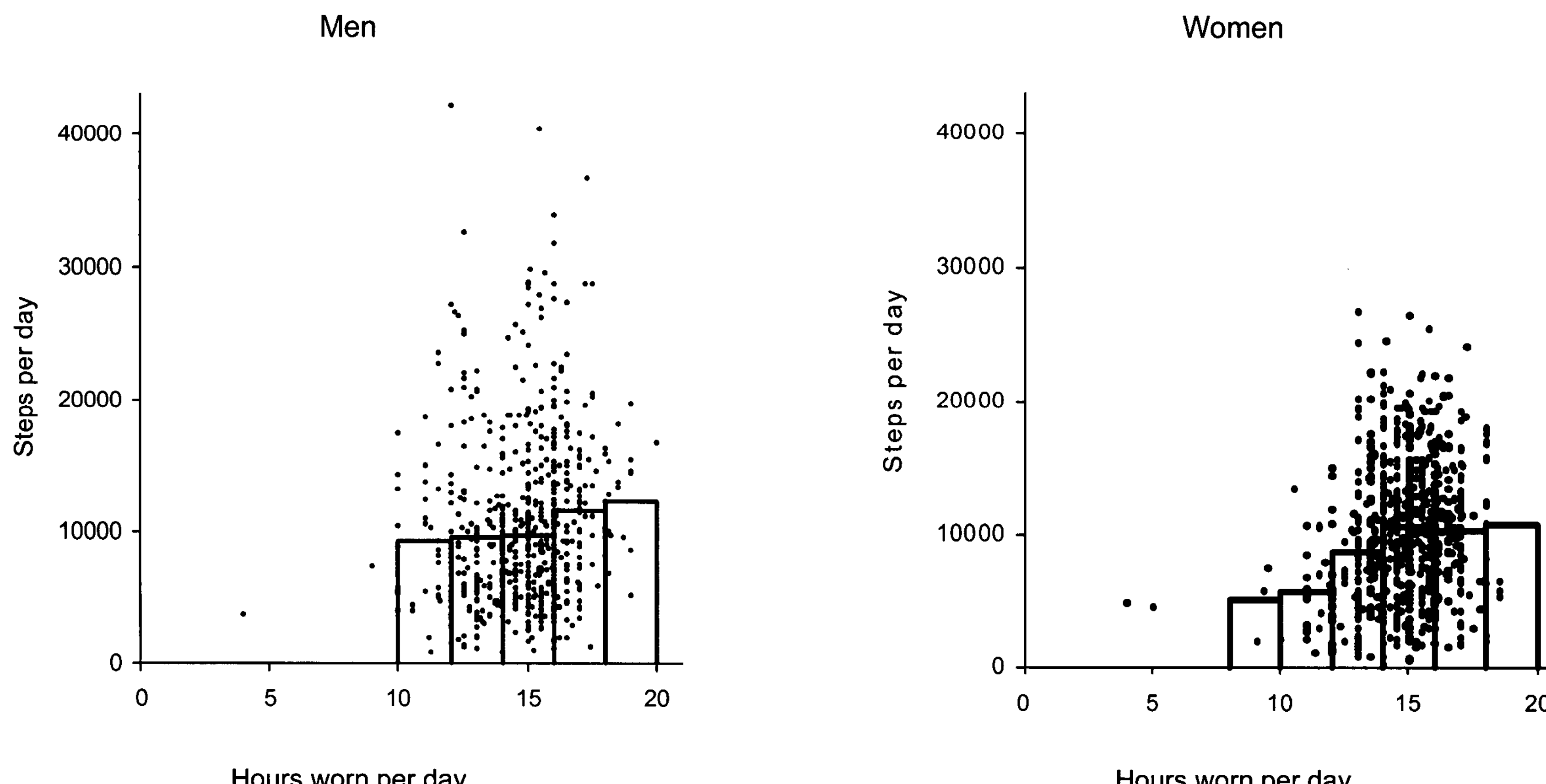

Figure 4.1: Plot of steps per day recorded by pedometer on up to seven days by 244 participants (119 men, 125 women) and the number of hours that the pedometer was worn each day for men and women. The boxes represent average steps recorded for each two hour time interval.

Table 4.2: Average steps for each day of week for all participants*.

	Day of week							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Av†
Men								
All								
Mean	9211.7	8972.7	9548.9	8814.9	8617.7	8664.7	8448.1	8814.1
SD	5887.8	5640.0	6055.0	5540.8	5481.6	4880.4	5131.8	4541.0
n	112	107	107	106	110	105	107	119
Urban								
Mean	9678.6	9030.6	10390.0	9029.9	8315.4	8375.9	8772.7	9078.3
SD	6129.7	5625.7	5958.4	5262.2	5549.2	4740.8	5506.8	4251.5
n	70	65	65	65	68	63	65	72
Rural								
Mean	8473.7	8883.7	8355.5	8482.5	9125.7	9112.8	8209.6	8421.2
SD	5486.7	5731.5	5937.0	5973.3	5363.6	5122.0	4595.2	4926.7
n	42	42	42	41	42	42	42	47
Women								
All								
Mean	9071.1	9373.9	9682.5	9087.3	9324.9	9449.2	9490.8	9118.2
SD	5092.9	5317.9	5142.7	4945.5	5026.3	5137.1	4488.5	4382.9
n	117	115	115	116	112	111	106	126
Urban								
Mean	9240.5	9282.5	10335.0	9225.1	8951.5	9575.3	9720.7	9248.2
SD	5526.8	4855.1	5087.5	5406.0	4494.9	4743.3	4514.8	4278.6
n	59	56	56	57	56	55	50	60
Rural								
Mean	8900.5	9460.9	9082.8	8955.3	9705.8	9326.1	9287.7	8966.2
SD	4668.8	5771.0	5144.5	4512.3	5555.3	5526.9	4494.5	4500.2
n	58	59	59	59	56	56	56	65

* This table excludes participants who rode motorbikes as their occupation or worked in water.
† Mean of all 7 days.

How many days are needed?

Average steps per day changed little when taken over more days of recordings (Table 4.3). The ICC comparing the average of successively more days of recording with the average of all seven days increased substantially when the number of recording days was expanded from one to two days, and increased further when it was expanded from two to three days. There were only minor increases by adding further days of recordings.

Table 4.3: Average steps per day and intraclass correlation coefficient (ICC) values at increasing number of days of recording for participants who completed all seven days of recordings (93 men and 93 women).

	Number of days recording						
	1	2	3	4	5	6	7
Men							
Mean	9225.0	9010.3	9080.6	9120.8	9078.1	8946.6	8825.6
SD	6015.4	5223.7	5094.6	5144.3	4942.6	4656.1	4421.7
ICC(1,k)	0.88	0.95	0.97	0.98	0.99	0.99	1.00
ICC(1,1)	0.79	0.91	0.95	0.96	0.98	0.98	1.00
Women							
Mean	9496.5	9546.1	9649.1	9612.4	9522.3	9487.4	9478.7
SD	5163.3	4790.6	4772.0	4553.1	4498.1	4378.4	4296.3
ICC(1,k)	0.90	0.96	0.97	0.99	0.99	1.00	1.00
ICC(1,1)	0.82	0.92	0.94	0.97	0.98	0.99	1.00

When steps for each day separately were compared with the average of seven recordings (data not shown), the highest correlations were for day 4 ($r = 0.91$) and day 3 ($r = 0.88$) for men, and day 3 ($r = 0.89$) and day 5 ($r = 0.87$) for women. Discarding recordings on day 1 and day 2 to allow a run-in period, the ICC(1,k) for day 3, 4, and 5 with the mean of seven days was not higher (0.98 for men and 0.98 for women).

Validity of pedometer measurements

Content validity

Among 235 participants who wore pedometers for at least three days, the six men who rode motorbikes as their occupation recorded more ($p = 0.004$) steps per day (mean = 15811, SD = 6442), and the seven men who worked in water recorded fewer ($p = 0.024$) steps per day (mean = 6142, SD = 2621), than the other male participants (mean = 9180, SD = 4247). Their PAR revealed the motorbike riders were doing little else than riding their motorbikes and those who worked in water were more active than their recordings suggested. These two groups comprised 5.5% (13/235) of participants with at least three days of recordings, and 5.2% (13/250) of the total sample. Excluding these 13 men from the assessment of measurement stability made little difference. The average numbers of steps per day for each day of the week for men excluding these 13 men are presented in Appendix 4A. The average steps per day for women was 9539 (SD 4290).

Concurrent validity

The correlations for the association between average steps per hour and the PAR estimate (Figure 4.2) was moderate for men ($r = 0.42$, $p<0.01$) and modest for women ($r = 0.26$, $p < 0.01$). The associations calculated with total steps per day were weaker for men ($r = 0.28$, $p <0.01$) and women ($r = 0.24$, $p < 0.01$). The six motorbike riders and seven water workers were excluded because their pedometer recordings did not reflect the activities recorded by the PAR.

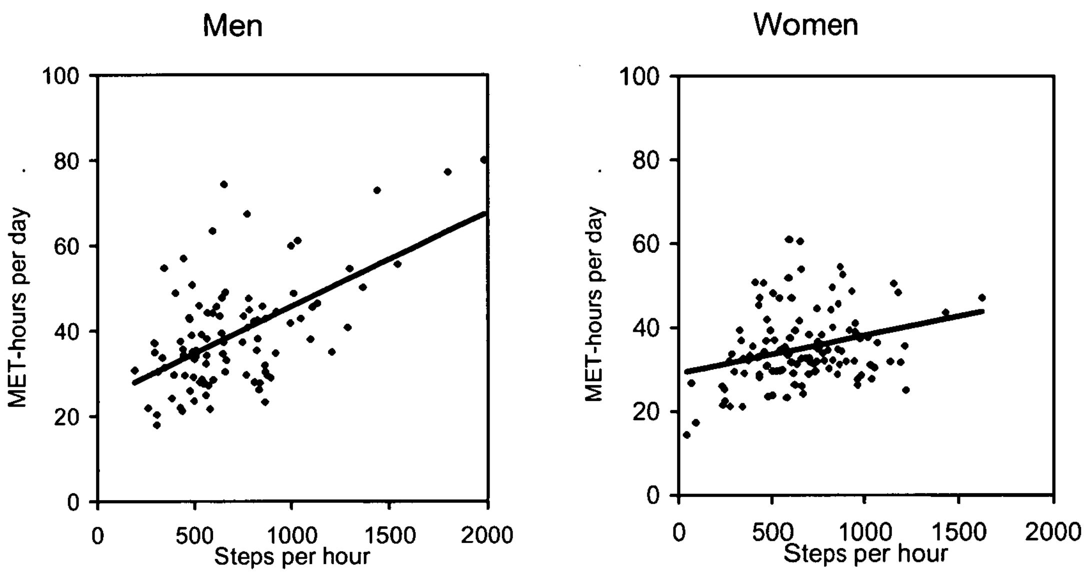

Figure 4.2: Plot of MET-hours per day recorded by physical activity records and number of steps recorded per hour obtained from 222 participants (101 men, 121 women) who wore pedometers for at least three days.

Predictive validity

The association with cardiovascular risk indicators were marginally stronger when calculated with steps per day than when calculated with steps per hour. For men and women combined, the age- and sex-adjusted correlations with steps per day were $r = -0.10$ (BMI), $r = -0.11$ (waist circumference), $r = -0.11$ (waist-to-hip ratio), $r = -0.09$ (systolic blood pressure), $r = -0.11$ (fasting blood glucose), and $r = -0.13$ (fasting total cholesterol). The corresponding correlations when using steps per hour were $r = -0.09$

(BMI), r = −0.10 (waist circumference), r = −0.09 (WHR), r = −0.07 (systolic blood pressure), r = −0.11 (fasting blood glucose), and r = −0.13 (fasting total cholesterol).

4.5 Discussion

To the best of our knowledge, this study is the first attempt to assess the use of pedometers as a measure of physical activity in Vietnam. Despite some minor operational issues, we found that it was feasible to use pedometers to measure ambulatory physical activity in Vietnam. Even though just one day of pedometer wear provided a high ICC, three days of wear provided a stable measure and there was no improvement in providing a run-in period. There was no evidence to support a requirement of a minimum number of hours of wear time per day. In addition, the pedometer recordings provided a reasonably valid indicator of total physical activity in this population as evidenced by the comparison of pedometer estimates against PAR estimates.

Our findings demonstrate the feasibility and acceptability of pedometer use in Vietnam. Firstly, 78% of the local population participated in the survey and nearly all of them (250/251) subsequently participated in this study. Studies in other populations have reported response proportions ranging from 17% to 69% (35, 39, 99, 100, 111). Secondly, there was excellent compliance in this study with 98% wearing pedometers for at least three days. Thirdly, failure to take proper care of pedometers and to return them was rare in this study. As demonstrated in our qualitative findings, a key contributor to this excellent compliance was the supportive role of the health volunteers. These local identities assisted with recruitment, encouraged continued participation, assisted with recording, and advocated the return of pedometers. Health volunteers are an integral component of the Vietnamese health system and the use of pedometers in large-scale surveys in Vietnam appears feasible with their assistance. They require training and continuing supervision, however, because some proved to be over-zealous and had fabricated records on occasion whilst others were not highly motivated. This will be an important issue to consider in future community-based research in Vietnam.

Attesting to the feasibility and validity of pedometer measurement in Vietnam, it was rare to find persons in our sample whose activities were such that pedometer usage was inappropriate. These persons included those whose occupation involved riding motorbikes and those working in water, but together they comprised only 5% of our sample. Based on this sample, pedometer measurement of ambulatory activities would be possible for 95% of the population.

In relation to the number of hours the pedometer must be worn, we found a positive association between steps recorded and wear time. For women, this association disappeared after 14.4 hours, but 32% of recordings by our sample of women would be lost if a minimum wear time requirement of 14.4 hours was imposed. We therefore recommend no cut point be used for both men and women in this population. These findings are consistent with an investigation of this issue by our own group (35) in a similarly aged sample of Australians. Further, we do not recommend that pedometer counts be adjusted for hours of wear when the purpose of the measure is to predict cardiovascular risk. While the differences were not large, the predictions were marginally stronger when made using steps per day than when using steps per hour. Obtaining information on steps per hours requires use of PAR and, in view of the complexity of the tasks of administering and extracting data from the PAR, and the limited predictive value of those data as measurements of physical activity in their own right, it is recommended that future studies utilising pedometers use steps per day as the measure of physical activity and employ a simplified form of the pedometer diary.

In this Vietnamese sample, the number of steps per day did not differ by day of the week. This finding is similar to that from a study of women in South Carolina (112). On the other hand, Tudor-Locke et al found a significant difference in steps recorded on weekdays and weekends in a sample from South Carolina (113) of similar ages to our participants but, in a subsequent analysis (92), concluded that the differences by day of the week were not of practical importance. Similar weekend effects have been reported in a population-based Australian study (114). The inconsistencies with our results may be due to the different populations being studied. The majority of our participants were self-employed and involved in activities such as farming that, in Vietnam, are not dependent on the day of the week.

Three days of wear were required to obtain a stable estimate of physical activity in our study. This finding is consistent with that from a US study (92) (with ICC = 0.79 for 1 day, 0.89 for 2 days and 0.94 for 3 days). Another study (115) reported that five days were needed to obtain stable estimates for 10-14 year olds, whose activities were highly variable, but only two days of recordings were sufficient for post menopausal women with diabetes who tended to be inactive. Similar to the finding of the US study mentioned above (92), we found that single day recordings on day three, four or five were most strongly correlated with the mean of all seven days. This may suggest that best practice would be to allow a run-in period of two days, thereby requiring five days of recordings, but doing so did not produce stronger associations in our study and does not weaken our conviction that three days is adequate.

Whilst pedometers measure ambulatory activity only, that activity is a major component of total physical activity, and it was reassuring that the recordings were at least modestly correlated with the PAR estimates. That the correlation was higher for men than women mirrors a previous finding of ours for a similarly-aged population-based Australian sample (35), and may be due to several reasons. Firstly, the activity of men was usually of higher intensity, whereas women's activities were usually of lower intensity and more fragmented. Higher-intensity activities may be more salient and recorded with less error. Secondly, pedometers are not designed to measure upper body movements involved in activities such as household work (116), which were more commonly undertaken by women in this sample. Thirdly, male participants generally had higher levels of education than did female participants, and may have been more adept at accurately recording their activities in the PAR without requiring help. Pedometers may have a particular advantage in measuring physical activity in populations with low levels of literacy.

The average steps per day for men (9180) and women (9539) in this sample are similar to the mean estimate from a meta-analysis summarising all 42 studies that used pedometers (9501 for men and women combined) (117). The figures in our sample are higher than those reported for population samples from US population in Colorado (men: 7028, women: 6602) (100) and South Carolina (men: 7192, women: 5210) (113) and comparable to estimates reported for a Swiss sample (men: 10400, women: 8900)

(39), lower than those of an Australian sample (men: 10900, women: 11200) (118), and much lower than a sample of Old Order Amish farmers (men: 18425, women: 14196) who abstain from using modern farm equipment and other conveniences (119).

The strengths of this study are its population-based sample recruited with a high response rate, the intensive training and supervision of staff and health volunteers during data collection, the vigorous procedures used in data checking, and the use of qualitative methods as an adjunct methodology to provide a deeper understanding of pedometer usage issues in the local population. These features provide some confidence that our findings present a comprehensive and accurate picture of issues involved in recording physical activity by pedometer in Vietnam.

This study has a number of limitations, however. Firstly, the lack of a gold standard measure of physical activity limited the assessment of concurrent validity to the PAR. The use of more accurate methods, such as doubly-labelled water or heart rate monitoring, were not feasible in this population-based study. Accelerometers provide a more comprehensive measure of physical activity than do pedometers, but are more expensive and less practical for large-scale population-based surveys. They also suffer from similar usage restrictions for the 5% of our sample who worked in water or spend the day riding motorbikes on bumpy roads. Moreover, pedometer measurements have been shown to be strongly correlated with accelerometer estimates of ambulatory physical activity (44, 47, 49). Secondly, our study did not take into account the inadequacy of pedometers in capturing activities such as riding bicycles (120). The amount of time spent on activities such as bicycling by our participants was minimal, however. Thirdly, the MET intensities used to calculate total MET-weighted hours of activity from the PAR in this study were based on the Compendium of Physical Activity (107), which was developed for the US population. We assigned MET intensities using the activities most similar to those undertaken by our participants, but could not find good matches for several of the local activities. Nevertheless, this is a problem in any study seeking to use this approach.

4.6 Conclusions

Pedometers can be used to obtain a reasonably valid estimate of physical activity in the Vietnamese population. At least three days of recording are needed to obtain a stable estimate of habitual activity.

4.7 Postscript

In this chapter I have shown that it is feasible to use pedometers to obtain a reasonably valid estimate of physical activity in the Vietnamese population. Understanding of the feasibility issues was derived partly from monitoring compliance using quantitative indicators such as number of days of wearing the pedometer and completeness of recordings, but largely from a qualitative study based on the observations and reflections of participants and health volunteers in respect of their experience of using pedometers to measure physical activity in Vietnam. The qualitative study is reported in the following chapter.

Appendix 4A: Additional results on pedometer use in Vietnam

4A.1 Introduction

This section provides the additional results on pedometer wear in the Vietnamese population. The average steps per day for each day of the week and in day order are presented for men and women. The average steps per day for men excluding those who had an occupation that could influence the pedometer recordings (including those who rode motorbikes or worked in water most of days) are shown and discussed. In this study, participants were asked to wear pedometers for seven consecutive days starting from the day following the STEPS survey clinics. Because the survey clinics always occurred on the weekend, participants either started their pedometer period of wear on Sunday (for those who attended the clinics on Saturday) or Monday (for those who attended clinics on Sunday). Whether a participant attended the clinic on Saturday or Sunday was decided randomly. Health volunteers were required to visit participants regularly to assist them with pedometer wear issues and with recording their activities in the physical activity record (PAR). The frequency of these visits was decided by the health volunteers based on their judgment of the need of each participant. The completeness of the pedometer diaries and the actual length of pedometer wear therefore varied between participants according to their levels of enthusiasm.

4A.2 Results

Table 4A.1 presents the average steps for each pedometer day in day order for men and women. Men who started their pedometer period of wear on Sunday appeared to have the last two days (Friday and Saturday) with fewer steps recorded relative to the mean of all seven days. Men who started their pedometer period of wear on Monday had the last day (Sunday) with fewer steps recorded. This is unlikely to be an effect of missing data from those who did not provide all seven days of recordings, because the overall average steps per days for men presented here are similar to that reported for men who provided all seven days recording only (8825.6) in Table 4.3 in Chapter 4. For women, no clear pattern of steps per day was observed.

Table 4A.1: Average steps for each pedometer day in day order.

Date started	Day of pedometer wear							
Sunday	1st Sun	2nd Mon	3rd Tue	4th Wed	5th Thu	6th Fri	7th Sat	Av*
Men								
Mean	9510.9	9556.8	10165.3	9632.5	9077.0	8302.6	8078.4	9434.3
SD	6336.0	5878.2	6366.7	6691.1	5485.5	5337.4	5441.5	4969.3
n	50	50	49	48	46	44	40	50
Women								
Mean	8680.5	9399.6	9452.3	9127.3	8573.3	8490.5	8864.2	8910.2
SD	4889.3	4553.1	5005.2	4482.9	4891.2	4420.0	4594.1	3866.8
n	67	65	64	63	62	59	49	67
Monday	1st Mon	2nd Tue	3rd Wed	4th Thu	5th Fri	6th Sat	7th Sun	Av*
Men								
Mean	8785.6	8481.3	8830.7	8999.6	8954.4	8421.1	8163.2	8385.3
SD	5724.9	5454.5	5065.3	5542.8	5201.9	4628.2	4762.8	4225.5
n	69	67	65	63	62	60	53	69
Women								
Mean	9078.2	9427.3	9507.2	9550.6	9688.1	10201.9	10073.5	9361.4
SD	5459.8	6262.2	5497.2	5631.2	5236.4	5420.9	5214.8	4959.8
n	58	58	57	55	52	50	44	58
Total	1st	2nd	3rd	4th	5th	6th	7th	Av*
Men								
Mean	9084.8	8928.4	9385.9	9269.1	9006.5	8370.8	8126.7	8814.1
SD	5961.8	5636.1	5624.1	6016.8	5296.9	4915.9	5036.0	4541.0
n	119	117	114	111	108	104	93	119
Women								
Mean	8863.9	9412.7	9478.1	9323.4	9073.3	9256.0	9426.7	9118.2
SD	5139.2	5402.2	5202.0	5021.0	5056.4	4925.7	4896.1	4382.9
n	125	123	121	118	114	109	93	125

* Mean of all 7 days

Table 4A.2 presents the average number of steps for each day of the week for men, excluding those who rode their motorbikes (n = 6) and those who worked in water most of days (n = 7). There was no consistent pattern of steps per day across days of the week in either rural or urban areas. The average steps per day for all seven days excluding these 13 men is similar to the results when these 13 men were included (see Table 4.2 in Chapter 4).

Table 4A.2: Average steps for each day of week for men

	Day of week							
	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Av*
All								
Mean	8480.7	9045.5	8959.9	9547.7	8864.7	8477.0	8728.4	8752.8
SD	5138.7	5633.8	5278.6	5655.7	5339.0	5361.5	4768.6	4370.6
n	95	100	94	94	94	97	93	106
Urban								
Mean	8463.7	9280.5	8572.8	10058.7	8925.9	8016.0	8433.9	8839.8
SD	5363.1	5812.5	5168.7	5646.8	5282.2	5321.8	4572.9	4062.6
n	59	64	59	59	59	62	57	66
Rural								
Mean	8508.6	8638.6	9643.9	8733.3	8762.2	9345.3	9211.3	8610.8
SD	4827.2	5380.2	5465.9	5608.6	5510.2	5347.9	5119.5	4877.1
n	36	36	35	35	35	35	36	40

*Mean of all seven days

4A.3 Discussion

Issues with pedometer measurements in respect of day of the week and day order were assessed in these analyses. We found no clear pattern of the size of the measurements varying with day of the week or day order that would support a recommendation to use some days of recordings and not others. Although men in this sample on average reported fewer steps on the last day of their pedometer period of wear, this was not the case for women.

Excluding the 13 men who rode their motorbikes or worked in water most of days did not change the average number of steps per day for each day of the week. The explanations for this are as follows. Firstly, as presented in Chapter 4, whilst men who rode motorbikes most of days tended to report more steps compared to other men, men who worked in water most of days tended to report fewer steps than other men. In addition, these 13 men reported similar levels of activity across the seven days of their pedometer period of wear. More importantly, they constituted a small percentage (5.2%) of the population and pedometers remain a suitable instrument to measure the population level of physical activity in Vietnam.

Appendix 4B: Physical activity record and pedometer diary

PHYSICAL ACTIVITY RESEARCH

Instruction for pedometer wear

Participant's Name
Address
Phone number (if applicable)
Pedometer ID ☐☐☐☐

1. After you get dressed in the morning, clip the pedometer firmly on your belt, trousers, skirt, etc. To make sure results are accurate, clip the pedometer above the point where the crease in a pair of trousers would normally be.

2. Open the front case of the pedometer and press the yellow RESET button.

3. Close the case and record the date and time of day (START TIME) in your pedometer diary.
4. If you change clothes, please move the pedometer to new clothes.

5. Please remember to take off the pedometer when you take a bath or go into water and put it back on after doing so.

6. At the end of the day before changing for bed, open the front case of the pedometer (without removing it from your clothing) and record the number displayed on the screen (DISPLAY NUMBER) in your pedometer diary.

7. Please make sure you have completed all relevant sections in your pedometer diary.

8. You need to wear the pedometer for 7 day. If you forget one day, please continue to wear for one more day. After you finished, the health volunteer will come and collect the pedometer and the logbook. We will see you at your house after three weeks to ask you some questions.

If you have any problems or questions please contact Dr. Au Bich Thuy, phone number 071- 730768 ext 133 or mobile phone: 0918 441901 .

PEDOMETER DIARY AND LOGBOOK

Day :......

A. Please enter details in table below

Date	Start time	Finish time	Display number

B. We also need to know approximately how many hours you spent travelling by cycle (as a passenger), car, bus, truck, boat etc., either as the driver or passenger while you were wearing the pedometer.

APPROX. TIME SPENT TRAVELLING:...

C. Please provide a brief continuous description of how you spent your day

Time interval	Activity	Intensity (circle 1)
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig

Please note and relate comments to the day/days and activities concerned if:

- anything unusual happens to you or the pedometer (e.g. you have been exceedingly active, you are unwell/injured, etc)
- the number of steps recorded does not seem to accurately reflect the energy expended for an activity that involve movements in vertical direction (e.g. weight-lifting, cycling, travelling on uneven ground, rowing, etc)
- you suspect the pedometer is not working correctly.

Comments for day 1..

PEDOMETER DIARY AND LOGBOOK

Day 7 (last day):......

A. Please enter detail in table below

Date	Start time	Finish time	Display number

B. We also need to know approximately how many hours you spent travelling by cycle (as a passenger), car, bus, truck, boat etc., either as the driver or passenger while you were wearing the pedometer.

APPROX. TIME SPENT TRAVELLING: ....

C. Please provide a brief continuous description of how you spent your day

Time interval	Activity	Intensity (circle 1)
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig
		Light Mod Vig

Please note and relate comments to the day/days and activities concerned if:

- anything unusual happens to you or the pedometer (e.g. you have been exceedingly active, you are unwell/injured, etc)
- the number of steps recorded does not seem to accurately reflect the energy expended for an activity that involve movements in vertical direction (e.g. weight-lifting, cycling, travelling on uneven ground, rowing, etc)
- you suspect the pedometer is not working correctly.

Comments for day 7...

Any other comments for the week..
....
....

Example 1: **PEDOMETER DIARY AND LOGBOOK**

Day :...1...

A. Please enter detail in table below

Date	Start time	Finish time	Display number
20/07/2005	5:30	22:30	6759

B. We also need to know approximately how many hours you spent travelling by cycle (as a passenger), car, bus, truck, boat etc., either as the driver or passenger while you were wearing the pedometer.

APPROX. TIME SPENT TRAVELLING: 30 minutes

C. Please provide a brief continuous description of how you spent your day

Time interval	Activity	Intensity (circle 1)
5:30-6:00	House weeping	Light Mod Vig
6:00-7:15	Go to market on foot	Light Mod Vig
7:15-9:30	Cook	Light Mod Vig
9:30-10:30	Teach child and prepare for his school	Light Mod Vig
10:30-11:00	fire wood cutting (chopping from medium pieces)	Light Mod Vig
11:00-12:00	Lunch	Light Mod Vig
12:00-12:30	Take child to school by motorbike	Light Mod Vig
12:30-1:30	Nap	Light Mod Vig
13:30-15:00	Pick grass in the yard	Light Mod Vig
15:00-16:00	Water trees (by a hose)	Light Mod Vig
16:00-17:00	Prepare for dinner	Light Mod Vig
17:00-18:00	Dinner	Light Mod Vig
18:00-18:30	Bath the child	Light Mod Vig
18:30-19:00	Bath self (pedometer not worn)	Light Mod Vig
19:00-20:00	Laundry (by hand)	Light Mod Vig
20:00-22:30	Watch TV until going to bed	Light Mod Vig

Note: - continuous time

- specify type of transport,

- describe work.

- time not wearing pedometer.

Please note and relate comments to the day/days and activities concerned if:

- anything unusual happens to you or the pedometer (e.g. you have been exceedingly active, you are unwell/injured, etc)
- the number of steps recorded does not seem to accurately reflect the energy expended for an activity that involve movements in vertical direction (e.g. weight-lifting, cycling, travelling on uneven ground, rowing, etc)
- you suspect the pedometer is not working correctly.

Comments for day 1..

Example 2:

PEDOMETER DIARY AND LOGBOOK

Day:...1...

A. Please enter detail in table below

Date	Start time	Finish time	Display number
15/09/2005	6:00	22:30	

B. We also need to know approximately how many hours you spent travelling by cycle (as a passenger), car, bus, truck, boat etc., either as the driver or passenger while you were wearing the pedometer.

APPROX. TIME SPENT TRAVELLING: 2 hours and 15 minutes

C. Please provide a brief continuous description of how you spent your day

Time interval	Activity	Intensity (circle 1)
6:00-6:30	Clean the house, prepare for going to work	Light Mod Vig
6:30-7:00	Go to work by motorbike	Light Mod Vig
7:00-11:00	Work at office, sitting at desk	Light Mod Vig
11:00-11:45	Go to market and back by motorbike	Light Mod Vig
11:45-12:00	Prepare for lunch	Light Mod Vig
12:00-12:30	Lunch	Light Mod Vig
12:30-13:00	Nap	Light Mod Vig
13:00-13:30	Go to work by motorbike	Light Mod Vig
13:30-17:00	Work at office, sitting at desk	Light Mod Vig
17:00-17:30	Go home by motorbike	Light Mod Vig
17:30-18:30	Prepare for dinner	Light Mod Vig
18:30-19:00	Dinner	Light Mod Vig
19:00-20:00	Clean the house	Light Mod Vig
20:00-20:15	Bath (pedometer not worn)	Light Mod Vig
20:15-22:30	Watch TV until going to bed	Light Mod Vig

Note: - continuous time

- specify type of transport,

- describe work.

- time not wearing pedometer.

Please note and relate comments to the day/days and activities concerned if:

- anything unusual happens to you or the pedometer (e.g. you have been exceedingly active, you are unwell/injured, etc)
- the number of steps recorded does not seem to accurately reflect the energy expended for an activity that involve movements in vertical direction (e.g. weight-lifting, cycling, travelling on uneven ground, rowing, etc)
- you suspect the pedometer is not working correctly.

Comments for day 1..

Appendix 4C: Common recording problems and suggested approaches for data processing of physical activity records

4C.1 Introduction

In the physical activity record (PAR), study participants were required to give a short description of their activities for each day, to report the time period in which the activities were undertaken, and to identify the intensity at which the activity was performed (light, moderate, vigorous). These diverse recordings were translated into physical activity estimates of hours spent on moderate and vigorous activities, and Metabolic Equivalent Task (MET)-hours per day. Prior to data entry, all the PARs were examined and common recording problems were identified, and approaches used to deal with them during data entry are presented here. The protocols were designed to be as specific as possible to help data entry operators deal with the recordings in a consistent manner. For this reason many issues that occurred frequently are presented as examples.

4C.2 Results

The following issues were identified. For each issue, a recommendation is provided for how to deal with it.

More than one activity occurred in the same time period

The recordings clearly stated that different activities had been undertaken in one provided time period, but these were not reported separately. The approach is to assume that each of these activities constituted the same proportion of time.

Example 1: "prepare meal and eat – 7: 00 am to 9:00 am".

Example 2: "walk around the village and watch TV – 6:00pm to 8:00 pm"

Suggested approach:

- Divide the total duration by number of distinct activities to get the time period for each activity.
- If the total duration is 15 minutes or less, do not divide, use the activity with lower MET value.

The report of the activity implied that many activities were included

The recording implies that more than one activity had been undertaken in the given time period, but these were not reported separately. The overall approach is to divide the activity recorded into component tasks. The components tasks were identified using the local knowledge of the researcher and the advice from local residents when needed. Do not divide if the activities are clearly stated.

Example 1: "dry rice". Unless clearly stated otherwise, this activity means taking the rice from inside the house out to an opened cement surface (vigorous), spreading the rice on the surface (moderate), occasional stirring, and covering at the end of each day (light) or packing and taking in at the end of the last day when the rice is dry (vigorous). It can take a few days for the rice to dry.

Suggested approach: usually the time taking the rice in and out is stated separately because it is a vigorous activity. If it is not, divide the time as follow:

- The first half (or the whole period if it is 15 minutes or less) of the first "dry rice" period recorded in the PAR is for taking the rice out. The second half of that period is for sitting and talking.
- The first half (or the whole period if it is 15 minutes or less) of the last "dry rice" period of each day is for covering rice, the second half is for sitting and talking.
- The first half (or the whole period if it is 15 minutes or less) of the last "dry rice" period of the last day of drying rice recorded is for taking the rice in, the second half is for sitting and talking.
- Other "dry rice" periods: half of the time is for stirring rice and the other half is for sitting and talking.

Example 2: "go to the market". In Vietnam, this is usually a daily activity. People can walk to the market, shop, and carry things home by hand; or they can go by motorbikes and only walk around to shop; or they can also go by boat (rowing or riding) to the market.

Suggested approach:

- If the activity is a daily task or is repeated many times, and one of those occurrences is described in detail, assume that the description applies to all such occurrences of the activity. Use those details for the rest of the similar activities. Participants often describe an activity in a detailed manner the first time and provide scant details on subsequent occurrences.

- Otherwise, allocate between component activities (travelling, walking around to shop) by assigning half of the time for walking around to shop and half of the time for travelling. For travel, assume that transport was by the same method that the participant regularly uses for other activities. If none is identified, use the most common type of transport used by other participants in the same village if known. If not, assume a sedentary form of transport (motored boat, car, bus) was used.

Example 3: "help in a wedding ceremony". Ceremonies are an important part of Vietnamese life. A ceremony often involves many people in the village and starts from early in the morning and lasts most of the day. A wedding ceremony in the Mekong Delta lasts on average two to three days. An annual ceremony to remember the day a grandparent passed away often involves one half-day of preparation by the family and one day of the main ceremonial activities for people in the village.

Suggested approach: If the period is 2 hours or less for one ceremony, it means sitting and eating at the ceremony only. If the time is longer, assume that the activities were as follows:

- boys and young men (<40 years old): helping with building temporary cover for party areas (50%), talking and eating (50%);
- girls (<20 years old): helping with decoration (25%), cooking (25%), washing dishes (25%), sitting and eating (25%);
- women (20-59 years old): helping with cooking (50%), sitting and eating (50%);
- older men (40+ years old) and older women (60+ years old): talking and eating (100%).

Travel time not itemised

Participants often recorded the main activity but not the travel to the place where the main activity occurred. The approach is to assume that the travel time was included in that time period. This issue is different from example 2 above because the travel in this case usually constituted only a small part of the total time, and therefore may have been overlooked by the participants.

Example 1: "cut the rice (harvest)- 6am to 1pm" is the only activity listed for the morning. Travel time to and from the rice field is not itemised.

Suggested approach:

If travel is described in one direction but not the other, or on other days for the same activity, apply that description. Otherwise, assume

- 15 minutes (or 25% if the total activity time is less than 60 minutes) for travel each way, and
- the most common form of travel is used (e.g walking).

The activity is not known

Occasionally the actual activity performed cannot be interpreted from the description in the recordings. The approach is to use the intensity provided by the participants, and assign the lowest MET value of activities in that category of that intensity.

Example 1: "go to work for others" (đi làm mướn, làm vần công)

Example 2: "recreation" (giải trí)

Suggested approach: if the activity is not described anywhere in the PAR, record as vigorous (MET = 6), moderate (MET = 3), or light (MET = 1) based on the information recorded on intensity.

Activities not recorded

Occasionally the time periods recorded for activities performed on the same day were not continuous, leaving a gap between activities. The approach is to treat these activities as missing (MET=1) based on the rationale that participants tended to report activities that were more salient and to overlook activities with low intensity (including rest).

Example: 7:00 am- 8:00 am: fishing using net (kéo cá).

10:00 am- 10:30 am: having lunch.

In this recording, there is no activity described for the time period from 8:00am to 10:00 am.

Suggested approach: record as missing (MET=1).

Additional guidelines

- Motorbike riders: unless clearly specified that the rider was riding for the whole period, assign half of the time for sitting (waiting for passengers).
- Hairdresser: assign only half of the time as active period and the rest is sitting and talking (Compendium code: 09100, MET=1.5).
- From the second day, participants tend to be brief and do not describe separately components such as travel and rest times. Use the description of the activity on the first occasion to record details of the activity on subsequent occasions.

4C.3 Discussion

These protocols assisted data entry personnel to systematically extract data from the diverse recordings of study participants. They can also serve as a resource for future researchers who wish to measure physical activity in the Vietnamese population.

Appendix 4D: Common types of activities in Vietnam.

4D.1 Introduction

Common activities reported in the physical activity record (PAR) by study participants are listed Table 4D.1. The activities were grouped into categories of tasks performed around the house, inside the house, for leisure, at work, for transport, and others. Activities which were described by different wordings but the descriptions indicated the same meanings were deemed identical (for example, "cut the rice" and "harvest rice" indicate the same activity). Each activity was given a code which was used for data entry purposes, a Metabolic Equivalent Task (MET) value, an intensity level (light: 1, moderate: 2, vigorous: 3), a Compendium code, and additional explanations if it is distinctive to the local population. When an activity recorded by participants was identical to an activity listed in the Compendium of Physical Activities (107), it was assigned a MET value provided for that activity in the Compendium. Otherwise, a modified MET value was used and the code of the activity listed in the Compendium that had the closest description was provided. A Vietnamese name/description of the activity is also provided to maintain the accurate identification of the local activity.

4D.2 Results

(see Table 4D.1).

4D.3 Discussion

These protocols provide the MET values for activities reported by study participants in this sample. Several local activities were not closely represented by those listed in the Compendium of Physical Activities (107). Further research to identify the MET values for these activities is needed.

Table 4D.1: Common types of activities in Vietnam

Code	Name of activity	MET	Intensity	Compendium code	Closest Compendium code	Additional explanations
	Around the house					
A1	Building a fence (làm hàng rào)	6.0	3	06050		
A2	Caulking boat (trét chay ghe)	5.0	2		06200	
A3	Chopping branches of tree for firewood (chặt nhánh cây lấy cũi)	4.5	2		08030	
A4	Collecting herbs for traditional medicine (hái thuốc nam)	3.0	2		11800	walking, collecting selected herbs
A5	Collecting snail (bắt ốc)	3.5	2		11800	
A6	Collecting vegetable for food (hái rau)	3.0	2		11800	walking, collecting selected wild vegetables for meal
A7	Collecting vegetable for pigs (hái rau cho heo)	4.5	2		11810	walking, cutting and carrying big quantity of wild vegetables
A8	Collecting water from river bank, 1 bucket (xách nước, thùng 20 lít)	5.0	2		11820	getting river water with 1 bucket, carrying with 1 hand
A9	Collecting water from river bank, by 2 buckets (gánh nước, 2 thùng mỗi thùng 20 lít)	7.5	3		11840	getting river water with 2 buckets, carrying by a board on the shoulders
A10	Cutting branches of bamboo to prepare the trunk for use (róc tre)	5.0	2		11260	
A11	Feeding pigs, clean up pig's house using a bucket (cho heo ăn, dọn chuồng heo)	5.0	2		11190	
A12	Feeding pigs, clean up pig's house using a sprinkler (cho heo ăn, dọn chuồng heo bằng vòi nước)	3.0	2		11190	
A13	Gardening, general (làm vườn)	4.0	2	08245		
A14	Preparing firewood, chopping (chặc cũi)	6.0	3		08020	
A15	Setting mosquito net for pigs (giăng mùng cho heo)	3.0	2		05165	
A16	Sweeping the yard (quét sân)	4.0	2	05140		
A17	Washing boat/car/bike (rửa xe)	4.0	2		11820	
A18	Watering vegetable with a bucket taking water from cannal/river (tưới cây bằng thùng, gào)	6.0	3		11820	
A19	Watering vegetable with a sprinkler (tưới cây bằng vòi)	2.5	1	05148		
A20	Weeding around the house (làm cỏ quanh nhà)	4.5	2		08240	
A21	Weeding the garden (làm cỏ vườn)	4.5	2		08240	
	Inside the house					
H1	Bringing clothes inside after drying, folding clothes	2.0	1	05090		
H2	Child care: baby sitting and feeding (giữ con nít, cho ăn)	2.5	1	05185		
H3	Child care: bathing and dressing	3.0	2	05186		
H4	Child care: carrying small children (ẵm con nít, chỉ tính lúc ẵm)	3.0	2	05181		
H5	Chopping plants and herbs for traditional medicine (chặt thuốc nam)	3.5	2		08030	
H6	Cleaning the house (quét nhà)	2.5	1		05140	
H7	Cutting vegetable for pigs (xắt chuối/rau cho heo)	5.0	2		06070	cutting banana tree to thin slides with a very big knife
H8	Drying herbal medicine (phơi thuốc nam)	2.0	1		17151	
H9	Home repair, carpentry, general	3.0	2	06040		
H10	Ironing clothes (ủi đồ)	2.3	1	05070		
H11	Mopping floor (lau nhà)	3.5	2	05021		
H12	Multitask in/around house, light (làm công chuyện nhà)	2.5	1	05025		
H13	Multitask in/around house, moderate (làm công chuyện nhà)	3.5	2	05026		
H14	Pounding banana tree for pig (quết chuối cho heo)	8.0	3		08020	
H15	Preparing meal (nấu cơm)	2.5	1	05052		
H16	Preparing ropes for packing rice straw (xé dây bó lúa)	2.0	1		09075	
H17	Pumping water from undeground (bơm nước từ cây nước bằng tay)	6.0	3		11660	
H18	Reclining with baby	1.5	1	05188		

H19	Self care, having meal (ăn cơm)	1.5	1	13030		
H20	Self care, sitting on toilet	1.0	1		13009	
H21	Self care, washing face, brushing teeth (vệ sinh cá nhân)	1.5	1	13035		
H22	Self care, washing, standing (tắm)	2.0	1		13050	washing oneself with a bucket of water or in a river
H23	Separating rice and broken rice (sàng gạo)	2.8	1		05171	sitting, moving a flat basket of rice to separate the broken rice
H25	Sitting and talking with others (ngồi nói chuyện chơi)	1.5	1	09055		
H26	Sitting, helping child with homework (dạy con học)	1.8	1		09040	
H24	Sitting, sewing by hand (may vá)	1.5	1	05080		
H27	Sitting, taking a rest (ngồi nghỉ)	1.3	1		09050	
H28	Standing, talking or talking on telephone	1.8	1	09050		
H29	Taking a nap	1.0	1	07011		
H30	Washing a motorbike	3.0	2		06220	
H31	Washing clothes by hand (giặt đồ)	4.0	2		05042	
H32	Washing dishes (rửa chén)	2.5	1	05042		
H33	Watching TV	1.0	1	07020		
H34	Writing by hand or on computer	1.5	1	11770		
	Leisure					
L1	Exercise, general (tập thể dục)	2.5	1	02101		
L2	Fishing, standing (câu cá)	3.5	2	04040		
L3	Hacky sack (đá cầu)	4.0	2		15310	
L4	Jogging (chạy bộ)	7.0	3	12020		
L5	Jogging and walking, combine (chạy và đi bộ)	6.0	3	12010		
L6	Jumping with a rope (nhảy dây)	8.0	3		02020	
L7	Lying on a hammock (nằm võng)	1.0	1	07011		
L8	Meditating (ngồi thiền)	1.0	1	07075		
L9	Sitting, drinking, eating and talking	1.5	1	09100		
L10	Sitting, having a coffee at a coffee shop (uống cà phê)	1.5	1		09055	
L11	Sitting, playing card (đánh bài)	1.5	1	09010		
L12	Sitting, playing chess (đánh cờ)	1.5	1	09010		
L13	Sitting, reading, (đọc sách)	1.3	1	09030		
L14	Sitting, singing (Karaoke)	2.0	1		9100	
L15	Soccer (đá banh)	7.0	3	15610		
L16	Swimming (bơi lội)	7.0	3	18200		
L17	Volley ball (bóng chuyền)	4.0	2	15710		
L18	Walking around the village, occasional stop (đi vòng vòng xóm)	2.5	1	17162		
L19	Walking around, slow (đi bách bộ)	2.0	1	17151		
L20	Walking, fast (đi bộ nhanh)	3.5	2	17160		
L21	Yoga (Tập dưỡng sinh)	2.5	1	02100		
	Miscellaneous					
M1	Attending church ceremony (dự lễ nhà thờ)	1.0	1	20000		
M2	Building a house from palm leaves and wood (cất nhà lá)	7.0	3		06050	
M3	Helping at a ceremony (e.g wedding), cooking	3.0	2		05052	
M4	Helping at a ceremony (e.g wedding), decorating	2.0	1		09080	
M5	Helping at a ceremony (e.g wedding), building a temporary house (dựng rạp đám cưới/hỏi/etc.)	5.0	2		06050	
M6	Patient care (chăm sóc bệnh nhân)	4.0	2		05187	

M7	Praying (cúng lạy)	1.0	1	20025		
M8	Raising incense (đốt nhang)	2.0	1		20036	
M9	Shopping (mua sắm)	2.3	1	05065		
	Occupation					
O1	Boat groceries, light (chèo ghe hàng, nhẹ)	5.0	2		18100	standing, rowing boat, frequence stopping, small load
O2	Boat groceries, moderate (chèo ghe hàng)	6.0	3		18100	standing, rowing boat, frequence stopping, moderate to big load
O3	Boat groceries, vigorous (chèo ghe hàng)	7.0	3		18100	standing, rowing boat, frequence stopping, heavy load
O4	Building a house, concrete (cất nhà tường)	5.5	2		11120	
O5	Building wooden boat (đóng ghe, xuồng)	4.0	2		11040	
O6	Catching frog (soi ếch)	4.5	2		11810	walking, catching frogs by hand, carrying the catched frogs on the back
O7	Construction work, general (thợ hồ)	5.5	2		11120	
O8	Crushing bean, making tofu (xay đậu làm tàu hủ)	4.0	2		11010	
O9	Cutting grass for cow by hand (cắt cỏ)	5.0	2		08030	cutting wild grass by hand with a knife
O10	Cutting tree, moderate (chặt nhánh cây)	4.5	2		08210	cutting branches of tree with an axe
O11	Cutting tree, vigorous (đốn cây)	6.0	3		08020	cutting the whole tree down with an axe
O12	Driving a bus/truck (tài xế)	3.0	2	16050		
O13	Driving heavy truck, load and unload truck at contruction site (lái xe tãi nặng)	6.5	3	11766		
O14	Farming, applying fertilizer on rice field (sạ phân)	6.5	3		11830	walking, carrying a heavy basket, distributing fertilizer when walking
O15	Farming, applying pesticide on rice field (xịt thuốc lúa)	7.0	3		11830	walking, carrying a heavy container of pesticide, spraying when walking
O16	Farming, collectting rice from dust after processing (gút bui bui)	5.0	2		11820	standing in water, moving a heavy basket
O17	Farming, digging (đào đất)	8.5	3	11540		
O18	Farming, dragging a cart (kéo cộ)	8.0	3		11140	
O19	Farming, drying rice in the sun, pack or unpack rice (phơi lúa, đem lúa ra sân hoặc đem vô)	6.0	3		11840	
O20	Farming, drying rice in the sun, walking, stirring rice (phơi lúa, quây lúa)	3.5	2		11800	
O21	Farming, feeding chicken/ducks (cho gà/vịt ăn)	4.0	2	11180		
O22	Farming, feeding fish (cho cá ăn)	3.5	2		11180	
O23	Farming, harvesting fruit, climbing tree (thu hoạch cây ăn trái, leo cây)	5.0	2		08246	
O24	Farming, harvesting fruit, from ground (thu hoạch cây ăn trái, đứng dưới đât)	3.0	2	08246		
O25	Farming, harvesting rice (gặt lúa)	8.0	3		11140	walking and bending, cutting rice with a special knife
O26	Farming, harvesting flooded rice (gặt lúa bị ngập nước)	9.0	3		11140	walking and bending, cutting wet rice with a special knife
O27	Farming, harvesting vegetable (thu hoạch dưa/bắp/đồ rẫy)	3.5	2		08250	
O28	Farming, herding cattles (chăn bò, trâu)	3.0	2		11150	walking, occasional running, and sitting on the cattle's back
O29	Farming, herding ducks (chăn vịt)	4.0	2		11150	walking, occasional running to herd ducks
O30	Farming, hoeing soil, moderate (cuốc đất)	7.0	3		11570	
O31	Farming, making a dam (đắp đập)	7.0	3		11540	using the soil on the field to make a temporary dam for water storage
O32	Farming, picking up young plants of rice for re-planting (nhổ mạ)	7.0	3		11570	standing, walking, pulling up rice, removing soil by smashing
O33	Farming, planting banana (trồng chuối)	7.0	3		11320	digging a whole big banana tree up, digging a new hole and put it in
O34	Farming, planting mushroom from rice straw (làm nấm rơm)	8.0	3		11140	making row of straw, watering by a hose with water from a canal
O35	Farming, planting seedlings (trồng cây)	6.0	3	11320		
O36	Farming, preparing soil for coming crops (làm đất)	6.5	3		11570	raking the soft soil to prepare for rice planting
O37	Farming, processing rice after harvest, light effort (tiếp suôt lúa, cầm bao)	6.0	3		11200	
O38	Farming, processing rice after harvest, moderate effort (suôt lúa)	8.0	3		11200	
O39	Farming, putting rice seeds (sạ lúa)	6.5	3		11830	walking, carrying a heavy basket, distributing rice seeds when walking
O40	Farming, replanting young rice to an empty field (cấy lúa)	4.8	2		11793	walking, putting young rice plants into the ground in rows
O41	Farming, replanting young rice to replace death plants only (dặm lúa)	4.5	2		11793	walking, putting young rice plants into the ground to fill in gaps

O42	Farming, taking mud from a pond/canal (dít sình)	10.0	3		11550	standing in a canal, digging mud and throwing it up to the ground
O43	Farming, visiting the rice field (đi thăm ruộng)	3.3	2		11792	walking, occasional stopping to fix a dam, or to weed
O44	Farming, watering rice field with a motor, setting up period only (bơm nước ruộng)	5.0	2		11820	walking around and checking the motor, fixing a dam etc.
O45	Farming, weeding rice field, light (nhổ cỏ lúa)	4.5	2		11793	walking between rice plants and pick out weeds
O46	Farming, weeding rice field, vigorous (phát cỏ)	9.0	3		11660	cutting wild weeds vigorously with a tool to prepare the rice filed
O47	Fishing by bamboo nets (đặt lờ, lọp, đuôi chuột)	2.5	1		04030	
O48	Fishing by many small fishing lines (cắm câu)	4.5	2		11810	walking, carrying many small fishing lines
O49	Fishing by net, light (giăng lưới)	2.5	1		04030	sitting on a boat, putting a net to the water, pulling up
O50	Fishing by net, light to moderate (cào cá)	3.0	2		04030	sitting on a boat, pulling a big net and collecting fish
O51	Fishing by net, moderate (chày)	5.0	2		04030	walking/standing on a boat, throwing a heavy net, pulling up
O52	Fishing by net, moderate (kéo lưới)	5.0	2		11820	walking in water, dragging a net
O53	Fishing, by hand (mò cá)	4.5	2		11810	walking in water and catching fish by hand
O54	Hair dresser (uốn tóc)	3.0	2		13045	
O55	Making baboo basket (đan giỏ/rổ, etc. tre)	2.0	1		09080	
O56	Making building material from palm leaves (chằm lá)	2.0	1		09080	
O57	Making food for sale (làm bánh bán)	2.5	1		11015	
O58	Making furniture (làm mộc)	4.0	2		11040	
O59	Making pots, growing flowers for sale-nursery (làm bội trồng bông)	2.0	1		09080	
O60	Motorbike driver (honda ôm)	2.8	1		16030	
O61	Motorbike driver, with carrier (xe honda lôi thùng)	2.5	1		16030	
O62	Office work (làm việc bàn giấy)	1.5	1	11580		
O63	Outdoor work, general	5.0	2		08245	
O64	Peeling banana (lột vỏ chuối)	2.0	1		11015	
O65	Photocopy shop (standing, photocopying and binding documents)	2.3	1		11520	
O66	Making mung bean sprout (làm giá)	4.0	2		08245	
O67	Recycle item collection, pushing a trolley, moderate (đẩy xe mua ve chai)	4.5	2		11805	
O68	Recycle item collection, rowing boat (chèo ghe mua ve chai)	6.0	3		18100	standing or sitting, rowing a boat, occasional stopping
O69	Repairing bikes (sửa xe)	4.0	2		06020	
O70	Repairing electronic equipment (sữa điện tử)	1.8	1		11580	
O71	Repairing shoes (sửa giày dép)	2.5	1	11530		
O72	Repairing watch (sửa đồng hồ)	1.5	1	11580		
O73	Riding bike- selling ice-cream/bread, frequent stopping (đạp xe bán kem, bánh mì, etc.)	7.0	3		01030	riding a bike with a big box at the back, frequent stopping when called
O74	Riding bike- selling lottery ticket, very frequent stopping (đạp xe bán vé số)	7.0	3		01030	riding a bike, frequent stopping to invite people to buy the tickets
O75	Roasting banana for sale (nướng và bán chuối nướng)	2.0	1		05050	
O76	Sawing woood by hand (cưa cây bằng tay)	7.0	3		11330	
O77	Selling things at home, light (bán tạp hoá tại nhà)	2.5	1		11610	sitting, occasional standing up to sale things
O78	Selling things at shop, moderate (bán hàng tại tiệm ở chợ)	3.0	2		11610	walking and standing, talking in shop, busy
O79	Setting up good in shop (bày đồ ra bán tiệm)	4.0	2		11800	
O80	Sitting, attending a meeting	1.5	1	11585		
O81	Sitting, selling cigarette (ngồi bán thuốc hút)	1.5	1		11580	
O82	Sitting, selling fish/chicken at the market (bán cá/gà vịt ở chợ)	2.5	1		11590	sitting, killing and cleaning fish/chicken, weighting them
O83	Sitting, selling things at the market (bán đồ ở chợ)	2.3	1		11590	sitting, weighting goods and collecting money
O84	Tailor, general (thợ may)	2.8	1		11730	
O85	Teaching at school (dạy học)	2.0	1		09071	
O86	Walking, carrying load, heavy (30-40kg)	7.5	3	11840		

O87	Walking, carrying load, light (5-10kg)	4.5	2	11810		
O88	Walking, carrying load, moderate (10-30kg)	5.0	2	11820		
O89	Walking, carrying load, very heavy (40kg+)	8.5	3	11850		
O90	Walking, carrying load, very light (<5kg)	4.0	2	11800		
O91	Walking, selling food at home (bán cơm/cháo tại nhà)	4.0	2		11810	walking around serving food, very busy
O92	Walking, selling lottery ticket (đi bộ bán vé số)	3.0	2	17162		
O93	Walking, selling things along the street, hand carry (bán hàng rong, xách tay)	6.0	3		11820	walking with a load of goods 10-20kg, frequent stopping
O94	Walking, selling things along the street, pushing a trolley (bán hàng rong, đẩy xe)	4.5	2		11805	walking, pushing a loaded trolley, frequent stopping
	Transport					
T1	Driving motorbike with trolley at the back (chạy xe honda lôi thùng)	3.5	2		16030	
T2	Driving motorbike, alone (chạy xe honda)	2.5	1	16030		
T3	Driving motorbike, with load (chạy xe honda chở đồ)	3.5	2		16030	
T4	Driving motorbike, with people behind (chạy xe honda chở người)	3.0	2		16030	
T5	Driving motorboat	2.5	1		18010	
T6	Riding boat/bus/car, sitting (ngồi ghe/xe)	1.0	1	16015		
T7	Riding push bike with someone behind (đạp xe chở người khác)	8.0	3		01015	
T8	Riding push bike, carrying things (đạp xe chở đồ)	9.0	3		01015	
T9	Riding push bike, general (đạp xe)	6.0	3	01015		
T10	Rowing boat, sitting (bơi xuồng)	4.0	2	18110		
T11	Rowing boat, standing, general (chèo ghe)	5.0	2		18110	
T12	Rowing boat, standing, moderate (chèo ghe chở nặng)	7.0	3		18110	
T13	Sitting behind a bike (ngồi sau xe đạp, honda)	1.5	1		16015	
T14	Walking (đi bộ)	4.0	2	17270		

Chapter 5: Issues to consider when using pedometers to measure physical activity in Vietnam: a qualitative approach.

5.1 Preface

The methodological issues involved when using pedometers to measure physical activity in the Vietnamese population were described in the previous chapter. The key issues identified were technical problems in attaching and wearing the pedometers, the literacy requirements involved in completing the pedometer diary and the physical activity record (PAR), the advocacy role of health volunteers, and the compliance of study participants. These all impacted on the participation levels and the measurements of physical activity. This chapter investigates these key issues using a qualitative approach to obtain additional and more detailed information. It is hoped that these cultural specific findings will provide guidance for future researchers when designing studies and collecting physical activity data at the population level in Vietnam and in countries with similar settings. A brief summary of the results presented in this chapter has been published together with the quantitative findings on pedometer use in Vietnam (57).

5.2 Background

Pedometers have increasingly been used to measure ambulatory physical activity in large scale population surveys in Western populations (35, 39, 100, 101). The successful conduct of these studies suggests that participants from those populations found it acceptable to wear a pedometer as instructed and to record wear details in a diary (35). It is not known whether this method will be feasible in a developing country where people have more limited levels of literacy. The applicability and cultural acceptability of pedometer use in such populations have not been explored.

The feasibility of pedometer use to measure physical activity in the Vietnamese population, and the stability and validity of the measurements obtained were assessed and reported in the previous chapter (Chapter 4). In the study reported, participants were required to wear pedometers for seven consecutive days, report their pedometer wear details, and provide corresponding PAR. To assist data collection, health volunteers – community members who involved in primary health care – were used as field staff.

The qualitative study reported in this chapter was embedded within the pedometer study. It aimed to provide information on issues associated with using pedometers and the PAR to measure physical activity in the Vietnamese population, including their cultural acceptability, and to provide a background description of the research setting for the study as a whole. It was anticipated that this information will be helpful in interpreting the quantitative data.

The specific objectives of this study were (1) to qualitatively evaluate the roles of health volunteers in the pedometer study, (2) to identify issues associated with the compliance of participants with pedometer use requirements, (3) to identify issues associated with the use of pedometers to measure physical activity, and (4) to identify issues associated with using the PAR to measure physical activity.

Definitions

The following terms will be used without further explanation.

Pedometer diary: a paper form for recording date, time of commencing pedometer wear, time of taking the pedometer off, and steps recorded for each day. Participants were asked also to report times they spent without wearing the pedometer during the day (e.g. swimming) and time spent riding motorbikes.

Physical activity record (PAR): a paper form for recording a description of all activities undertaken during the day, the times at which they took place, and the intensity (low, moderate, vigorous) of each activity. There was space available for participants to add comments. Two example pages with common patterns of activities were included in the instructions to guide participants when making entries in their PAR. For the purpose of the physical activity study, the pedometer diary and PAR were integrated into one document (see Appendix 4B).

Health volunteers: In Vietnam, health volunteers (also called village health workers) are responsible for delivering basic health services such as contraceptives, vaccination reminders, and monitoring adherence to prescribed medication regimes for persons living in an assigned local area of their neighbourhood (103). The health volunteers maintain and regularly update a list of the persons in their assigned area. In the pedometer study, the health volunteers invited eligible subjects to come to the study clinic, reminded participants to wear their pedometers, helped them to fill in the PAR if needed, acted as contact person for the researcher and participants, collected the pedometer diary and PAR on completion, and distributed small gifts to participants when they had finished their pedometer recordings. Health volunteers do these jobs in addition to their form of work (such as farming) and receive monetary compensation for their contribution.

Participants: men and women who participated in the pedometer study.

Informants: men and women who participated in this qualitative study, including health volunteers and participants in the pedometer study.

5.3 Procedures

The field of qualitative research is very broad and there is considerable diversity within it. Some of the key features of qualitative research that underpin this project are outlined below. The key sources are Creswell (121, 122), Patton (123), Hansen (124), and Grbich (125).

Characteristics of qualitative research

(1) The data collection process occurs where the activities of interest usually happen, such as informants' homes or workplaces.

(2) The methods used in qualitative research are humanistic and interactive. Informants are encouraged to become involved in the research and the contexts are not controlled. Rapport is essential between the researcher and informants.

(3) The qualitative researcher's own view is to some extent reflected in research findings and is thus viewed as being integral to the research. Because of this, it is usual for the researcher to be 'up front' about their role in the research and their relationship to the research informants rather than assuming a neutral objective stance (for example, the researcher is often someone who has similar age, ethnicity, or experience with the informants). Consequently, qualitative researchers use first person when reporting the findings.

(4) Research findings are interpreted by the researcher in terms of the social or cultural context of the research. These findings are often not to be used to generalise to the broader population in terms of proportions or prevalence, but may be transferable to similar contexts or situations.

(5) Qualitative research design is emergent. Data collection tools are revised and changed over the data collection process in response to preliminary findings and as researchers gauge the relative success of particular methods.
(6) Qualitative research is iterative. The research problem is often refined and altered during the data collection process.
(7) Qualitative research allows the researcher to better understand the perspectives of study informants. It helps the researcher understand social contexts and allows for a more complex picture of issues being studied to be developed.

Strategy of inquiry

This study used a pragmatic approach to qualitative research that involved 'asking opened-ended questions' and 'observing matters of interest in real-world settings' without necessarily being concerned about theoretical frameworks for qualitative research (123). In other words, the methods used 'can be separated from the epistemology out of which they have emerged' (123).

Role of the researcher

Qualitative researchers frequently adopt a participatory, collaborative role rather than the objective "expert" role often taken in quantitative research (124). The knowledge and understanding of the researcher about study informants is very important to the overall success of the study. Establishing and maintaining rapport is critical in order to gain the trust of informants (122). Summarised below are my roles in this study, my background and past experiences which could be helpful in building rapport with informants and in understanding the data, my connection with the informants, and the drawback of my involvements in the study.

Design and conduct of study

I was the person who designed the study, undertook the data collection (interviewing, having informal conversations, and taking field notes), and performed data analysis.

Researcher's background and past experiences

I come from a remote village of the Mekong Delta. At the time I was a female medical doctor and a university lecturer in my early thirties. I had been involved in various population health studies involving local people, including the project for my Master thesis on chronic pesticide poisoning among farmers (126).

Connection with informants

As the coordinator of the population survey and the quantitative pedometer study, I had the authority to have frequent contact with the health volunteers and participants. I met each health volunteer to arrange the survey clinics (and occasionally stayed at their houses during the recruitment of participants). I trained them in pedometer and PAR administration. On clinic days I worked with them to administer pedometers, and to identify participants who needed special help. Afterward I followed up with them by telephone. I met them again when I collected pedometers and PAR, and when they guided me to participants' home for the second visit. Finally, I met them to collect the second PAR.

The participants also interacted with me on a number of occasions thoughout the study period. They were very friendly and receptive. No informants refused to participate in an interview.

The drawbacks of my involvements

My background assisted me in building rapport with informants and gave me valuable insights. Nevertheless, my close involvement in the study sometimes made it harder for me to step back and take a fresh approach. For example, reflecting my concerns that people would not enjoy wearing a pedometer at all, the first version of the interview topic guide that I designed focused on mostly negative points. However, many of them found wearing pedometers to be a pleasant experience. Another disadvantage was that informants may have been reluctant to tell me things that were negative about the study, because they worried that it would make me feel bad as the coordinator. I overcame this by using many approaches to collect data rather than relying on interviews only.

Ethical approval

The study was approved by the Ethics Committee of Can Tho University of Medicine and Pharmacy. Written informed consent was obtained from participants after the objectives and procedures of the research were explained to them. Those who could not sign the form provided verbal consent. During data collection, participants openly discussed pedometer related issues, what help they needed to provide the data, and how they found that assistance. These topics were not considered too personal for people to share in the Vietnamese culture. The health volunteers also were very comfortable sharing their personal experiences. Informants who were photographed approved for their photos to be used.

Sampling methods

The informants comprised all of the 15 health volunteers involved in the quantitative pedometer study, and 26 study participants. The participants were selected by a combination of maximum variation, typical cases, extreme or deviant cases, and opportunistic sampling techniques (123) with the aim of including information-rich cases. Maximum variation aims at "capturing and describing the central themes or principal outcomes that cut across a great deal of heterogeneity of participant or program variation" (123). This method was used to obtain a sample of informants with a wide range of levels of literacy, occupations and motivation. Typical case sampling is the method used to select cases that are "typical" or "average" based on their demographic characteristics and information from key informants (123). This method was used to select participants who had a typical occupation, an average level of education, and –in the opinions of the health volunteers– average level of motivation. Extreme or deviant case sampling is the method used to select cases that are rich in information because they are unusual or special in some ways (123). This method was used to select participants who earned their living by driving people around on their motorbikes, and participants who were illiterate. Opportunistic sampling is the method that "takes advantage of whatever unfolds as it unfolds" (123). This approach was used to select participants who raised issues of interest when responding to my brief "screening" questions. The screening questions were asked when I was administering the quantitative physical activity questionnaires (the Global Physical Activity Questionnaire – GPAQ and the International Physical activity Questionnaire – IPAQ) or simply socialising. Screening questions could be: "Did you have any problem with the pedometer?", or "What do you think about the pedometer? Anything you want me to know? Anything I could have done better?", or "Who filled in your PAR and pedometer diary?"

Data collection procedures

Data collection occurred from July 2005 to December 2005 at all six sites of the pedometer study. The methods of data collection involved semi-structured and informal interview techniques. They are described below.

Semi-structured interviews (124) utilise a list of interview questions. These questions are a memory guide for the interviewer. There is no restriction on how and in which order the questions should be asked. The interviewer is also free to ask further questions in response to issues the interviewee may raise. Semi-structured interviews are used when the researcher knows most of the questions to ask but cannot predict the answers (127). The main benefit of semi-structure interviews is that they ensure the researcher can get all the information needed and at the same time they provide participants with the opportunity to describe things in their own words (127). In this study, semi-structured interviews were performed at participants' houses at the visit three weeks after the clinic day. The interviews were carried out without the presence of the health volunteer and focused on the following issues: (1) problems encountered while wearing a pedometer, and how they were dealt with; (2) any activity that the pedometer could not capture; (3) issues with pedometer diary and PAR; and (4) the role of health volunteers. As is usual in iterative qualitative research designs, the topic guides were revised after field visits if the data obtained indicated the need for additional questions (122) (see Appendix 5A for the English translation).

Informal interviews are "casual conversations in which the questions are spontaneous and based on interaction between researchers and respondents" (125). The data obtained from these informal interviews are often recorded in field notes and can be highly valuable (124). This approach was used to obtain information from health volunteers including (1) their views as a health volunteer in this study, about how they completed their duties, and why they chose to do the job, and (2) issues encountered with participants and pedometers.

Data recording procedures

There is a wide range of methods available to record qualitative data. Those used in this study were field notes, interview notes and commentary written on the PAR.

Field notes are "notes taken by a researcher to record incidents, observations or contextual information" (124). Lofland (128) classifies field notes into three categories: "mental notes", "jotted notes" and "full field notes". Mental notes concerns such matters as "who and how many were there, who said what to whom, etc." Jotted notes consist of "all the little phrases, quotes, key words, and the like that you put down during the observation and at inconspicuous moments". They act as "memory triggers" for later descriptions. They are then used to compose the more detailed notes called full field notes.

During data collection jotted notes were used to quickly jot down what I needed to remember. These consisted mostly of single words or simple phrases. This method was used to record interviews because audio recording was not available. I also made notes on the interview topic guide sheets of the points made by informants and of their key sentences. When an interview was lengthy, I provided a summary at the conclusion of the interview and cross-checked with the informants. Later, I used these jotted notes to compose much more detailed notes about what had happened, in what context they had happened, my interpretation of them, how I felt and what I thought should be done next in the study. These were my full field notes.

In qualitative research, photographs can be used as a data source to "capture the faces, activities, and routines of those studied" (128), and to generate "a shared understanding of context, emotions experienced and events surrounding the persons and incidents portrayed" (125). In this study, I used the photos to illustrate some of the issues described in the text.

Data analysis procedures

There are many different analytical procedures in qualitative research. This study used an iterative thematic approach (125). The analysis procedures of this approach consisted of seven phases: (a) organising the data, (b) immersion of data, (c) generating categories and themes, (d) coding of data, (e) offering interpretations through analytic memos, (f) searching for alternative understandings, and (g) writing the report or other format for presenting the findings of the study (129). How I applied this approach in the study is described below.

A key strategy was to review field notes and the PAR at the earliest possible opportunity. Issues that attracted my attention (such as inconsistency between what else was known about the participants and what were reported in PAR) were identified as topics to mention at interviews. For example, during the pedometer period a health volunteer phoned to inform me that one participant had lost his pedometer; in his pedometer diary, however, all seven days of recordings had been made. Questions to clarify this were asked at the semi-structured interview for that participant.

After data collection was finished, field notes and interview notes were recorded in electronic documents. The data from commentary written on PAR were not entered because the context and meaning would have been changed if they were transferred to an electronic version in this way.

These were then exported into Nvivo7 (130), a software package used to assist in the analysis of qualitative data. Using this package, patterns and issues were identified and then coded to create categories of analysis. I then read and re-read the documents and reviewed the analysis, utilising all available data (including those written on the PAR) to clarify the meanings underpinning the categories. Finally these categories were sorted and combined to produce a list of key themes.

Strategies used to strengthen the credibility of the qualitative findings

There are many strategies that could be used to strengthen the credibility of qualitative research findings. The approaches (121, 124) used in this study were as follows. The first approach was triangulation of data by using multiple sources of information including health volunteers, participants, PAR and pedometer diary. The second approach was to use rich, thick description to convey the findings. This approach provides readers with information about the setting from which issues arose, and with sufficient examples of data recordings to support analytical statement and claims. I also explained the way I interpreted the data, and acknowledged that my interpretations were based on cultural understanding and experience.

5.4 Findings

The qualitative research findings support the conclusions that it is feasible to use pedometers and the PAR to measure physical activity in Vietnam. The majority of participants were compliant, but some issues with pedometer and PAR use during the study were identified. These problems were addressed during the data collection phase and thus had very little impact on the quality of data collected overall. However, they are discussed below with the other findings.

The themes identified in the qualitative data are presented below. They are organised under four over-arching categories: Health volunteers, Participants, Pedometers, and Issues with Pedometer Diary and PAR. These are followed by a collection of photographs showing the setting for the study and giving a picture of the physical environment. Supporting quotes were taken from semi-structured interviews, informal conversations, and commentary notes written on pedometer diaries and PAR.

Health volunteers

Why health volunteers chose the job

For these 15 health volunteers, the reasons for choosing their health volunteer role were: (1) Their desire (6/15) to benefit the community with their literacy levels. One reported the wish to "*just try to be useful. Otherwise I just sit around with my arthritis*"; (2) The opportunity (1/15) for periodical training and connection with the health centre and, for this health volunteer who had a small pharmacy, to attract more customers; (3) a community involvement (8/15) to start a political career. One health volunteer kept telling me that he deserved a better position in the village because of his contribution: "*I should have been the head of the village, considering all the work I have done*"; (4) Finally, although the health volunteers did not state it during their interviews, assisting with the research earned them a little extra money, and this was likely to be incentive for their participation. Health volunteers, like others living in this region, receive a very low income.

Contributions of health volunteers

Illiterate participants needed a health volunteer to help them every day. One stated that "*when it's my bedtime, I just ran next door to auntie N and showed her my machine, she* *wrote down the number in the paper, and asked me what I did during the day"*. In addition, many participants could report the data by themselves but needed help at the start and frequent checking. One confessed that he *"can't be sure. Have to rely on her for that"*. Moreover, a health volunteer could arrange the participants to help one another when their houses were far from his or her own. One reported that *"in that group of participants, Ms. X finished grade 12, she took care of them all, Mr. Y was responsible for helping Mr. Z who was illiterate and lives next to him"*. Lastly, one participant was deterred from wearing "*the machine*" because he suspected it was for the "*experimental purposes of some medical students*". The health volunteer convinced him to wear his pedometer.

Problems with health volunteers

<u>*With recruitment*</u>

Participating in the study provided participants with an opportunity to talk to a doctor, to have people pay them attention, and to receive some small gifts. In consequence, some ineligible persons attempted to participate in place of eligible persons who were unavailable at the time of the clinics. The health volunteers who knew the villagers helped identify eligible participants and explained to ineligible persons that they could not participate. One ineligible person did participate in the study despite the health volunteer being aware at all times that the individual was not eligible. Afterward, at the three week follow-up, the health volunteer confessed that the person was ineligible. The related records were removed from use.

<u>*Health volunteer availability*</u>

When the study coincided with their other work, the health volunteers sometimes ignored their research duties. In one such case, a health volunteer was busy with a political training course and did not visit any of her 12 participants. All of the records were incomplete when she handed them to me, and all needed re-administration. This was a conversation at a follow up call. I asked "*Ms. H, how is your work going*?" She replied "*Not going anywhere?"* (her tone saying "How can I do it with all these work?". I asked "*Oh, what's wrong?*". She answered calmly: *"Have a political training course. Haven't done anything yet"*. In Vietnam where political training is given the highest priority, she was telling me that she had a perfect reason not to fulfil her research duties.

<u>*Impact on data*</u>

Health volunteers in general were trustworthy at data collection. However, a few problems were identified. The first problem was failure to understand the instructions. This was manifested on one occasion when a health volunteer reported at a follow up telephone call that a participant had disagreed with her on what he was required to do. The participant was correct. I clarified the issue with the health volunteer.

The second problem was that a health volunteer could fabricate information to replace missing data. This did occur on rare occasions. For example, a participant reported that he accidentally immersed his pedometer in water on the third day, and that the health volunteer "*came to check the next day and was upset about that. So he took it all back. That's it*". However, on the record of this participant, recordings had been made for all seven days. The recordings for the first two days had different hand writing than those of the last five days. The fabricated data were removed accordingly.

When health volunteers fabricated data, they thought that they knew the participants' regular activities and could guess to complete the PAR. A health volunteer, who had little time to follow up with his participants due to his political training course, showed me an empty PAR and asked "*Can I just fill it in? I know very well what she does*". When I explained the need for accurate recordings of actual activities, the other health volunteer from the commune said "*You can't just make it up by guessing, you need their first day to do so*". (These comments relate to data from the re-administration of the PAR and are not used in this thesis, and do not affect the data presented).

Participants

Overall, participants were willing to participate in the pedometer study and followed the instructions. Issues related to participants included influences of the surrounding environment and compliance matters.

Circumstances and surrounding

In Vietnam, people live closely together and have great interest in the lives of others. Before data collection, there was a concern that circumstances and surrounding may influence the participants' compliance. For example, participants might remove their pedometers to show others, and thereby interfere with the measurements being made.

However, most participants felt that *"the machines"* were very important and were very proud to have them. One reported that *"I said it was a tape recorder"*.

On the other hand, the health volunteers reported two occasions in which the surrounding had influence. Both involved gatherings of drunken men. In the first case, the participant decided to fill in his pedometer diary and PAR at the party. His PAR was heavily stained and ruined from exposure to liquid, and the hand writing was illegible. In the second case, the men took the pedometer from the participant and hid it. A few days passed before it was returned to the participant.

Compliance with instructions

Compliance issues including failure to follow instructions about wearing the pedometer, recording information, taking care of pedometers, and contacting the researcher when in need. The pedometer diary, PAR and interview notes showed that most people complied with the instructions and did so enthusiastically. A man reported in his PAR: "*Today the pedometer count only 2000 step when I have been active all day, so I think it is not working. Even if I only count walking around the rice field for two hours would be many more steps than that!*".

On the other hand, one woman said that she was too busy to remember to wear the pedometer. She stated that "*I have twin babies. Waken up in the morning by the babies, no time to think about the pedometer*". Another participant said that when her pedometer reading was very high compared to recordings made by others, she became worried and recorded a much lower number. She reported that "*I was running around the park in the morning, and the number on the machine kept going up. I was scared. Thought I got some disease*". Another compliance issue was that some people did not wear their pedometer in the evening. One person reported that "*I took it off at 6pm…went to bed at 9pm…because I was done with work, just rested and watched TV*". Two participants only wore pedometers at work and took them off at home. One of them stated "*I change to home-outfit after work. The pedometer looks awkward on the shorts*". Lastly, one participant said that she gave it to her daughter to wear when taking a shower. Her words were "*I worried that it would malfunction if nobody was wearing it*".

In one case, a health volunteer suspected that a participant wanted to keep her pedometer. The health volunteer noted that "*She first said to me she lost it on the rice field. Another day she said she lost it when she was taking water out of her boat. I know she was lying. I know her family just so well*".

Participants reported that the cost prevented them from contacting me when they had trouble with their pedometers (for example, when a replacement was needed). A phone call could cost an amount equivalent to salary of a half day of physical work. Moreover, not every house had a telephone and many participants would have had to use a neighbour's phone. Depending on their relationship with the neighbour, even receiving a call could be subject to a '*service charge*'. In fact, it was only at the last site of the pedometer study –where participants were relatively wealthy – that I received phone calls.

Pedometers

Most participants did not have any significant problem with pedometers. The minor issues identified by participants were loss or damage to pedometers, problems during pedometer wear, some activities that pedometers may fail to capture, and lack of familiarity with pedometers.

Loss and damage

Of the 62 pedometers used, two were lost and four others were damaged. Of the lost pedometers, one was dropped into a fish pond toilet (a toilet built on top of a fish pond), and the other was reportedly lost in the rice-field (but the health volunteer suspected that it was kept intentionally). Of the damaged pedometers, three resulted from contact with water accidentally. The other was lost on a construction site and was later found to be damaged.

Problems encountered while wearing a pedometer

Technical problems

This study used two models of pedometers. The Yamax SW200 had only one button (the reset button) and was used most of the time. The Yamax SW700 had three buttons in a more complicated setting. The adjustment settings allowed activity to be recorded in kilocalories rather than steps, and this caused confusion when a participant pressed a wrong button and changed the mode of recording. Moreover, a pedometer could work normally during calibration but fail to record correctly afterward. This resulted in some participants reporting numbers like "88888" or "8.8.8.8.8."

Participant burden

For some people, participation resulted in discomfort, unease due to fear of forgetting to wear the pedometer, and nervousness related to pedometer wear. One reported that he "*Just can't feel natural. Always remember that I was wearing a pedometer*". A participant who sold fish at the market said *"it annoyed me every time I bend down"*. In one case, a participant had misunderstood the reason she had been selected to participate whilst others (of the population survey) had not. She feared that she must have had some serious disease, and became worried but did not ask for an explanation. The health volunteer and I remained unaware of this until afterwards at the follow-up interview.

Activities that pedometers may fail to capture

Activities that prevented participants from wearing pedometers included working in water (deepening a channel, fixing a dam, harvesting rice in flooding season) and activities that occurred out of water but involved contact with water (such as fishing that may require them to swim past a channel, or jump into the water, and drying rice in the sun in the wet season that may require them to pack up their rice in the rain).

Lack of familiarity

Participants reported that they trialled different ways to wear their pedometers. A participant covered his pedometer with a plastic bag when he was working on a flooded rice field. Another participant reported wearing pedometer on the back side of his waistband when watering his fruit trees to protect it from getting wet.

Issues with pedometer diary and PAR

The pedometer diary and PAR were completed by participants, family members, neighbours, and health volunteers. Most people did not have any problems remembering their activities at the end of the day. Those who did were motorbike drivers and grocery shop owners. Motorbike drivers earn their living by driving people from place to place on their motorbikes. It can be very difficult for them to remember how much time they sat on their bikes waiting for customers, and how much time they travelled. A passenger may come at anytime and the number of passengers per day also varies. One said "*Imagine you were sitting on your bike at the rear of market looking on for passengers,* *when one turns up, you rush to her, like that, how could you remember the time?"*. All six motorbike drivers were unable or reluctant to complete their PAR. One explained that *"I left the PAR empty, not because I did not want to report, I just could not. Now that I've explained to you, you know why"*. Similarly, those who had a shop at their home (for example, selling groceries in front of their house) had fragmented activities that depended on how busy the shop was. They said it was hard to recall each time period at the end of the day. One reported that she spent *"All day on my feet running like a chicken that need to lay an egg"*. One participant was a "secret" policeman (a policeman not in uniform) and he refused to give details of his daily activities in the PAR, stating only *"work activities as usual"*. Lastly, some participants suggested that the example page of the PAR should be in the front, not at the back, to make it easier to follow.

Photos

The photos below reflect the context of the study.

1. The first photo shows local children on a farm. The un-sealed road in the background was in good condition (but bumpy) when it was dry and sunny.
2. The second photo captures an urban area where people have shops in the front of their houses and their living areas at the back or upstairs.
3. The third photo was taken when we were on our way from the health volunteer's house to participants' houses in a new residential area of the commune. We rented a boat that cost 70,000 VND (about 6 AUD at the time), the equivalence of two working day's salary for physical work. When the health volunteer had to visit these participants, he could either pay this amount or he could ride his bike (if it was not raining and the road was not muddy).
4. The fourth photo was taken at a survey clinic located at a health volunteer's house and her coffee shop. The health volunteer (standing) and I (sitting) were reviewing the check-in list at the reception table (left).
5. The fifth photo shows the view from the survey clinic in the fourth photo. A participant said that he swam across the river everyday to get to his farm.
6. The sixth photo shows the front of a commune health centre. Communes have approximately 10,000 people (up to 10 villages).

7. The seventh photo shows a home visit for recruitment of participants for the population survey. The family was glad that the man (middle) was selected to be involved in the survey. The health volunteer (second from right) and her husband (first from left) introduced me to the family.
8. The last photo was taken at a participant's house during a semi-structured interview. As you can see, interviews are communal activities in Vietnam! The participant was telling her story in a jovial manner in the company of her neighbour (who was also a participant), while I was taking notes in the middle of the picture.

Photo 1: Local children on a farm with a bumpy road at the back.

Photo 2: A busy urban area. The shops are in the front of people's homes.

Photo 3: On the way to participants' homes. From left: our health volunteer, myself, and one of my staff.

Photo 4: A survey clinic located at a health volunteer's house.

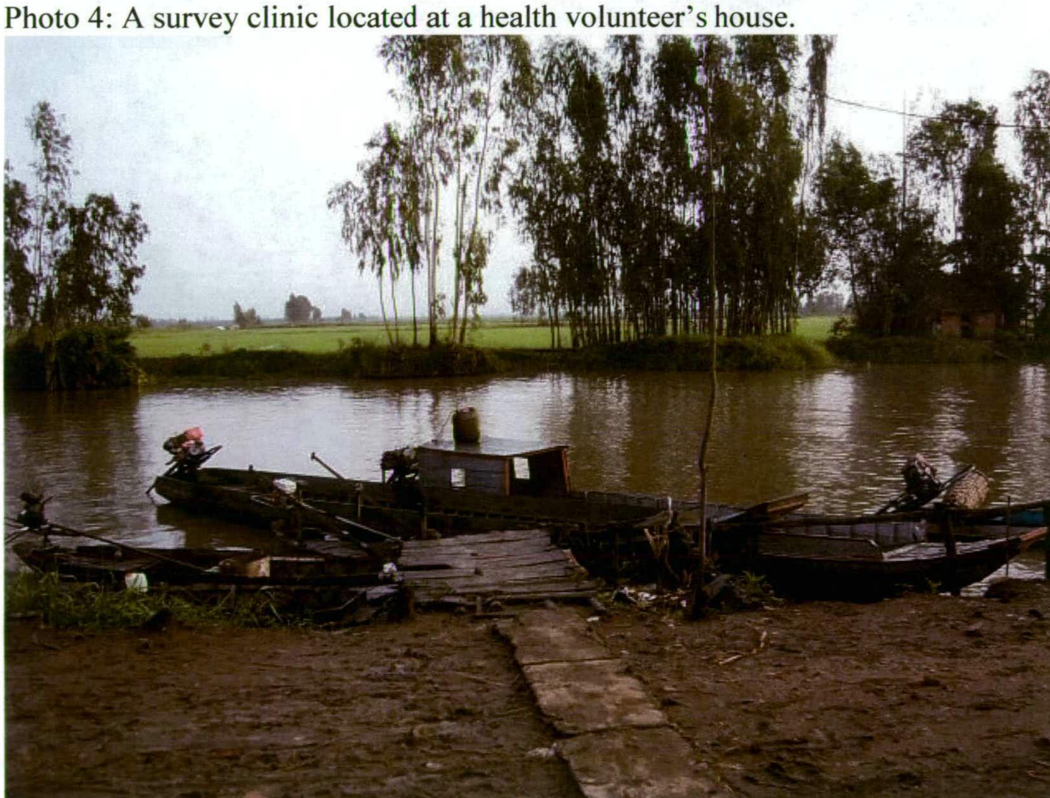

Photo 5: The view from the clinic (in photo 4).

Photo 6: A commune health centre.

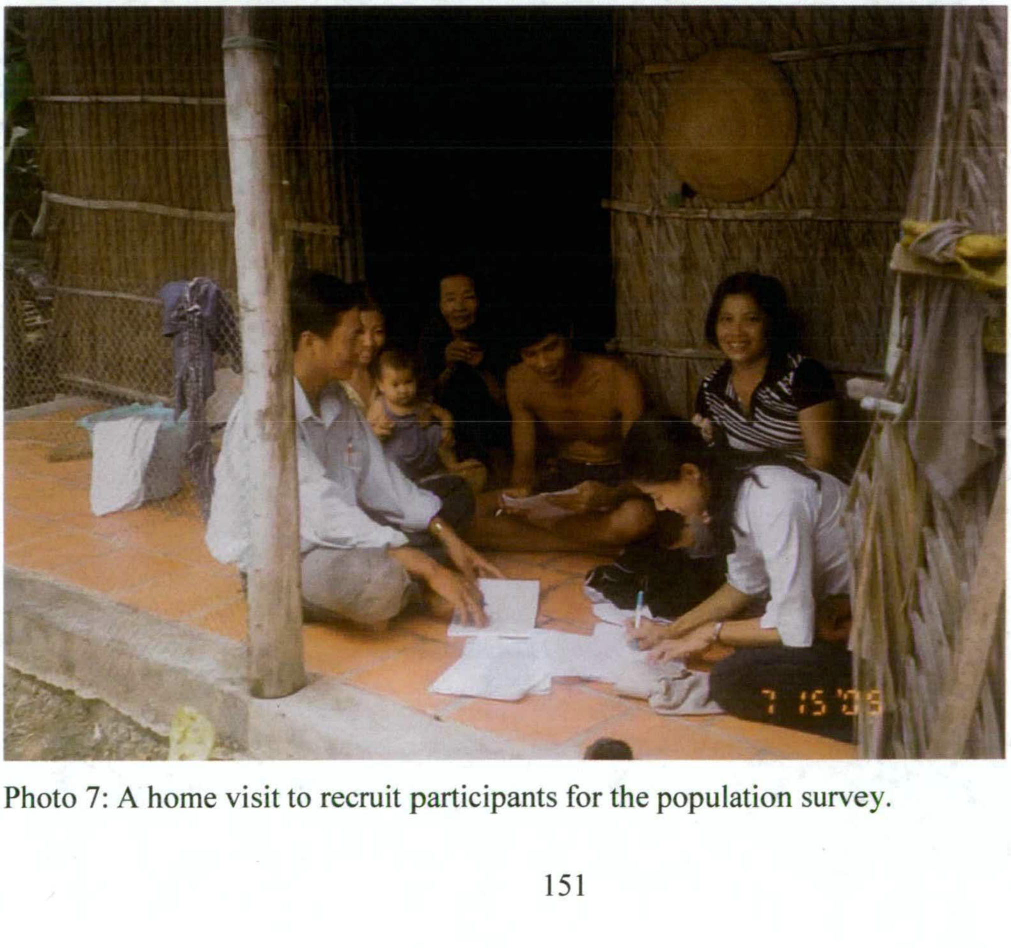

Photo 7: A home visit to recruit participants for the population survey.

Photo 8: A semi-structured interview in a participant's home.

5.5 Discussion

This qualitative study aimed to provide information on issues associated with using pedometers and PARs to measure physical activity in Vietnam. The findings confirmed the conclusion that it is feasible to use pedometers and PARs to measure physical activity in the Vietnamese population. The minor issues that arose were addressed during the data collection phase, and thus had very little impact on the quality of data collected overall. Nevertheless, they provide insight into the process of pedometer research in Vietnam and highlight areas where other researchers conducting similar research will need to pay careful attention.

The health volunteers played critical roles in this study. Firstly, they served as a gateway for the researcher as an outsider to enter the village and be accepted. In Vietnam, where "*a close neighbour is better than a distant relative*" (proverb), the health volunteers (close neighbours) helped the people to gain trust in the researchers. Secondly, because the villages are often remote, health volunteers assisted in data collection and provided administrative help in issuing and retrieving the pedometers.

The different levels of enthusiasm and devotion of the health volunteers may have reflected the reasons they chose the job. Those who became a health volunteer with the aim of helping people were the most enthusiastic and helpful. On the other hand, those who chose the work as a political pathway often attended political courses and gave lower priority to their research work and were less likely to fulfil their duties (and they occasionally fabricated information to replace missing data). This highlights the need to use multiple sources of help rather than relying on the health volunteers only, especially when health volunteers have other priorities. Triangulation and cross-checking of data and on-going training and supervision of health volunteers are essential to ensure the validity of data obtained.

In a wider context, the utilisation of health volunteers is a unique feature of the Vietnamese health system. This system was initially formed to make use of retired nurses especially those who stopped working in 1975. It was then expanded to involve non-medical persons. There may not be persons with an equivalent role in the health systems of other countries. The applicability of the findings from this study may be limited to the Vietnamese setting only. On the other hand, the type of follow up performed by the health volunteers may be worth considering by other researchers, even in developed countries, because it improved the level of participation. In studies conducted in Western populations (35, 39, 99, 100, 111), participation (17-69%) has been lower than that achieved in this study.

In contrast to our initial concerns, the use of pedometers and PARs in this population-based setting was confirmed as being feasible. Firstly, we found that most participants took very good care of their pedometers and returned them promptly. The support of the health volunteers, at least in part, may have helped this. Secondly, the complaints of participants about pedometer use were mild and infrequent. Thirdly, there were few activities that pedometers failed to record accurately and the use of a PAR can provide information about those activities. For those who work in water most of the time, a PAR will complement the pedometer readings by capturing information on the activities. On the other hand, for those who rode motorbikes most of the time, their pedometer recordings could be rendered inaccurate by bumpy road surfaces and their PARs were not particularly helpful because of the unpredictable nature of the work. The motorbikes drivers tended to have low levels of activity when working, and any salient physical activity would be performed out of work and thus could be reported accurately.

While the participants were cooperative, their involvement was in some cases circumscribed by the complexity of the study. Although few participants were illiterate, many others did not fully understand the procedures and would have failed to provide accurate data without the help of the health volunteers. To avoid this in future research, more emphasis will need to be placed on explaining procedures to the participants. Although the low level of literacy appears to be a restriction of pedometer use currently, this problem is expected to be reduced overtime because the adult illiteracy rate in Vietnam is decreasing (131).

Similarly to this research, a study in a US population in South Carolina (99) showed that a "vast majority" of participants reported no problems using pedometers and a calendar to monitor their physical activity, and that the data collection process was not burdensome. However, in stark contrast to our study, 44.4% of those participants failed to return the data sheets (with or without a pedometer) despite three follow-up telephone calls. This suggests that there are barriers to full participation for persons in those populations other than the inability to record information.

The restriction of pedometer usage in water is an issue that was highlighted in this study. Besides swimming or working in water, activities that involved high risk of unexpected contact with water also prevented participants from wearing pedometers. Although some participants tried different ways to wear pedometers underwater (by placing them in plastic bags, for example), these practices were discouraged because I was concerned about the accuracy of pedometer recording when they were not worn as instructed. Until water-proof pedometers become available, this issue will remain unresolved.

This study benefited from a sample of informants who were selected to have diverse characteristics. There was a wide range of data collection methods involved and the use of multiple sources of data allows triangulation of information. The multiple contacts between the researcher and the informants helped form a strong bond and understanding, and data collection went smoothly as a result. In addition, my background knowledge of the local population facilitated interpretation of the qualitative data.

This study suffers from some limitations, however. Firstly, the qualitative interviews were not audio-recorded and then transcribed. This prevents a secondary analysis by other researchers by way of cross-validation. However, the nature of the data is rather straight forward, and quotes from participants were noted down at the time of the semi-interviews. A second limitation is the rather narrow scope of the research. Because the main purpose of this study was to focus on problems with pedometer and PAR use and on methods of solving them, we were unable to explore other wider issues related to physical activity that might have been interesting and useful (for example, enablers and barriers to participating in physical activity). Additionally, being the only person involved in the qualitative data collection and analysis was both an advantage and a disadvantage. Being so closely involved assisted my interpretation of the research data. However, it was difficult at times to be a fully reflective and self-critical qualitative researcher when there were no other researchers to provide interpretations that could challenge my own.

In conclusion, the use of pedometers and PARs to measure physical activity was confirmed to be feasible and well-accepted in this Vietnamese population. The involvement of health volunteers was critical and they should receive sufficient training and supervision.

5.6 Recommendations arising from the qualitative findings

The recommendations are detailed below.

Do:

- make sure that health volunteers understand their work thoroughly, and that they are dedicated to the work. If not, find an appropriate substitute before data collection starts;

- contact health volunteers regularly (preferably every day) by phone or any means possible to reinforce the data collection requirements and encourage them to work;
- calibrate every pedometer before issuing them to participants, and remove damaged pedometers from use;
- explain to participants that it is very important to report the actual display number for the day of recording, and not to report a modified or fabricated number;
- explain to participants (and reinforce if necessary) that the pedometers are not harmful;
- provide health volunteers with a few spare pedometers in case some of the pedometers at the site are damaged;
- quickly check the data, and double-check with participants if necessary, to clarify any recording issues at the time of retrieving the pedometer diary and PAR (in the village);
- put an example page of the pedometer diary and PAR in the front of the pedometer document;
- have a toll free telephone number available.

Do not:

- put too much pressure on health volunteers to obtain the full seven days of pedometer recording because they may fabricate information to replace missing data (adopt the stance that fewer days of accurate recordings are adequate if there are difficulties in obtaining recordings);
- rely totally on the health volunteers. When there is alternative help available (from a family member or a close neighbour), make use of the alternative source particularly if they live in close proximity and are available. This reduces the workload for the health volunteers, and allows them to focus on other participants. Doing so is particularly important if the health volunteer is not reliable.

5.7 Postscript

In this chapter I have shown that measuring physical activity in Vietnam requires not only the basic methodological knowledge that has been documented in the literature from quantitative studies conducted in developed countries, but also cultural insights about how the data are obtained. These findings indicate that with careful planning and appropriate involvement with the local community, physical activity at the community level can be measured accurately using pedometers. Taken together, the findings from Chapter 3, 4, and 5 show that, in this population, physical activity questionnaires need to be used with care (by taking into account the participants' changing work patterns, for example), and that the use of pedometers is feasible and should be encouraged.

Until objective data are available, questionnaire data serve as a crucial source for preliminary investigations into the complex association of physical activity and non-communicable disease (NCD). This understanding will in turn add significantly to the knowledge of how physical activity should be measured. In the chapters that follow (Chapter 6 and 7), I will examine the role of physical activity as a predictor of cardiovascular disease (CVD) risk factors, using the physical activity data obtained by GPAQ from the STEPS survey. In the next chapter (Chapter 6), potential confounders and effect modifiers of the associations of physical activity with CVD risk indicators are investigated.

Appendix 5A: Qualitative interview topic guides

QUALITATIVE INFORMATION ABOUT PEDOMETER AND PHYSICAL ACTIVITY RECORDS BY RESEARCHER

(To be used to interview study participants)

(the first draft used)

1. Did you have any difficulty in terms of using pedometer (Probe for interviewer: pedometer fell off, forget to put on after taking off, uncomfortable...)? (circle one)
   a. Yes
   b. No.
2. If yes, what were they and why did that happen?

....
....
....
....
....

3. Was there any time during the day that wearing pedometer causes you discomfort?
   a. Yes (go to 4)
   b. No (go to 6)
4. If yes, when?

....
....
....
....
....

5. If yes, did this cause you to take off the pedometer?
   a. Yes, at which occasion:
      ....
      ....
   b. No
6. Could you fill in the diary by yourself?
   a. Yes (if yes, go to question 5)
   b. No
7. If No, who filled in the diary for you? ....
8. Did you or the person that helped you have any problem in filling the diary (probe for interviewer: could not remember time spent on activity, took too long, etc)?
   a. Yes
   b. No
9. If yes, what were they?

....
....
....
....

10. Was it difficult to remember to wear pedometer for 7 days? What did you do when you forgot to put pedometer on or back on after taking off for some reason?

....
....
....
....

11. How did others respond when they saw you wearing the pedometer?

....
....
....
....
....

12. What did you do in response to them (probe: took off to show, stopped wearing, try to influence the count of pedometer)?

....
....
....
....
....

QUALITATIVE INFORMATION ABOUT PEDOMETERS

AND PHYSICAL ACTIVITY RECORDS BY RESEARCHER

(To be used to interview study participants)

(one of the drafts used after early ongoing data analysis)

Participants ID number: ....

The following items should be addressed:

1. Difficulty in terms of using pedometer (Probe: pedometer fell off, forget to put on after taking off, uncomfortable...)? What, why, when.
2. Participant's response to those matters (take it off, ..)
3. Issue with filling in diary and PAR:

- Who fill in?
- Any problem with filling (probe: could not remember time spent on activity, took too long, etc.), specify?

4. Social response when subject wearing the pedometer. Specify.
5. Subject's response to those reactions (probe: took off to show, stopped wearing, try to influence the count of pedometer)?
6. Any activity that cannot be recorded by pedometer and PAR? Specify.
7. How helpful was your health volunteer?
8. In your opinion, how can measuring of physical activity be improved?

Chapter 6: Confounders and effect modifiers of the associations of physical activity and cardiovascular disease risk indicators.

6.1 Preface

Previous chapters, particularly Chapter 3-5, have focused on the measurement of physical activity in Vietnam. An important remaining issue is to assess the predictive validity of the measurements of physical activity by GPAQ. This will be done in Chapter 7, where the association between physical activity and CVD risk indicators – body composition, blood pressure, blood glucose (BG) and total cholesterol (TC) – will be investigated. To prepare for this ultimate step, the associations of other behavioural risk factors (smoking, alcohol use, fruit and vegetable consumption) with physical activity and with CVD risk indicators are examined in this chapter. The purpose of these investigations is to identify potential confounders or effect modifiers that will need to be taken into account when examining the association of physical activity with the CVD risk indicators in Chapter 7. Appendix 6A presents a detailed examination of the association between smoking and hypertension. The material presented there has been published in a peer-reviewed journal (58).

6.2 Introduction

Lifestyle factors including cigarette smoking, alcohol use, fruit and vegetable intake, and physical activity have been identified as determinants of cardiovascular health (132-135). These health risk behaviours often cluster together (136), and may interact with one another in complex ways in pathways leading to CVD. For example, whilst physical inactivity is associated with higher body mass index (BMI), smoking has been linked to reduced weight (137). In addition, smokers are often inactive (138). When the association between one behavioural risk factor and CVD is examined, it is important to take into account the effects of the others.

The aim of this chapter was to identify whether any of the other behavioural risk factors measured in STEPS surveys (smoking, alcohol intake, fruit and vegetable consumption) was a confounder or effect modifier to the association between physical activity and CVD risk indicators (body composition, blood pressure, BG and TC).

6.3 Methods

Subjects and sampling

This study utilised data from a population-based survey (n= 1978) of risk factors for non-communicable disease (NCD) of 25-64 year old residents of Can Tho in the Mekong Delta, Vietnam. The survey was conducted using the "STEPwise approach to surveillance of non-communicable diseases" (STEPS) methodology. Eligible subjects were selected by multistage sampling with age, sex, and urban/rural stratification. Details of the sampling process have been provided in Chapter 2. Informed consent was obtained from participants. The study was approved by the Ethics Committee of Can Tho University of Medicine and Pharmacy.

Measurements

Measurements by questionnaire consisted of demographic characteristics, socio-economic factors, and four behavioural risk factors (smoking, alcohol consumption, fruit and vegetable consumption and physical activity). Physical measurements included weight, height, waist circumference, hip circumference, and blood pressure. Biochemical measurements included fasting BG and TC. All measurements were performed in accordance with the STEPS protocols developed by the World Health Organisation (WHO) (67). Details of these measurements have been provided in Chapter 2.

Statistical methods

Data were coded and presented according to the WHO guidelines (67). Hours of physical activity of moderate and vigorous intensities were weighted by their Metabolic Equivalent Task (MET) values provided in the guidelines (moderate activity is assigned a MET of 4 and vigorous activity is assigned a MET of 8). Analyses were performed using STATA software version 9.2. Because the measurements of physical activity were mal-distributed and right skewed, Spearman correlation coefficients were used to summarise the associations between physical activity and smoking, alcohol intake, fruit and vegetable intake. Pearson correlation coefficients were used to present the association between these behavioural risk factors other than physical activity and CVD risk indicators because the measures were normally distributed.

6.4 Results

The associations between physical activity and other behavioural risk factors are presented in Table 6.1. For women, physical activity was not associated with any of the other behavioural factors. For men, alcohol intake was positively associated with MET-hours of moderate and vigorous activity per week. In contrast, number of years of smoking was marginally associated (p = 0.09) with lower level of physical activity. Adjusting for age diminished the association of physical activity with number of years of smoking (r = 0.01) and attenuated the association with alcohol intake (r = 0.06).

Table 6.1: The association between physical activity (MET-hours per week) and other behavioural non-communicable disease risk factors.

	Men (N=911)		Women (N=1067)	
	n	$r^{\dagger}$	n	$r^{\dagger}$
Smoking duration (years)	875	–0.06	1045	0.02
Alcohol intake‡	894	0.08^{*}	1045	–0.02
Fruit+ vegetable intake§	904	0.02	1048	–0.01

† Spearman correlation coefficients
* *p<0.05*
‡ The number of standard drinks consumed in the last 7 days.
§ The total number of serving of fruit and vegetable per day.

Table 6.2 presents the association of smoking and alcohol intake with CVD risk indicators for men. These associations were not examined for women because of the low prevalence of smoking and alcohol use in this subgroup. For men, smoking was inversely associated with BMI and positively associated with waist to hip ratio (WHR) and systolic blood pressure (SBP). Alcohol was positively associated with WHR, SBP, BG and negatively associated with TC.

Adjusting for age de-attenuated the associations of smoking duration in years with waist circumference (r = –0.12, p < 0.001) and with TC (r = –0.09, p < 0.01) but attenuated the associations of each index of cumulative tobacco use with WHR (number of years of smoking: r = –0.03, pack-years r = 0.02) and with SBP (number of years of smoking: r = 0.01, pack-years r = –0.02).

In further investigations, after adjusting for age, BMI, and alcohol intake, smoking was found to be associated with hypertension in a dose-response manner when characterised as number of years of smoking and lifetime cigarette consumption, but not when characterised as smoking status. These findings are reported in Appendix 6A.

Table 6.2: The association between smoking and alcohol intake and cardiovascular risk indicators for men (N=911).

	n	$r^{\dagger}$
Smoking duration (years)		
Body mass index	877	-0.16^{***}
Waist circumference	880	-0.03
Waist hip ratio	878	0.13^{***}
Systolic blood pressure	851	0.17^{***}
Blood glucose	836	0.01
Total cholesterol	838	0.03
Cigarettes smoked (pack-years)		
Body mass index	736	-0.10^{**}
Waist circumference	739	0.01
Waist hip ratio	737	0.13^{***}
Systolic blood pressure	719	0.11^{**}
Blood glucose	703	0.01
Total cholesterol	704	0.03
Alcohol intake‡		
Body mass index	896	-0.01
Waist circumference	899	0.03
Waist hip ratio	897	0.10^{**}
Systolic blood pressure	870	0.16^{***}
Blood glucose	853	0.10^{**}
Total cholesterol	838	-0.08^{*}

† Pearson correlation coefficients.
‡ The number of standard drinks consumed in the last 7 days.
$^{*}p<0.05$ $^{**}p<0.01$ $^{***}p<0.001$

Table 6.3 presents the association between fruit and vegetable consumption and CVD risk indicators. For men, fruit and vegetable intake was positively associated with BMI, waist circumference and BG. Adjusting for age resulted in negligible changes. For women, fruit and vegetable intake was inversely associated with SBP. Adjusting for age diminished the association of fruit and vegetable intake with SBP ($r = -0.03$) but increased its correlations with body composition to become significant (BMI: $r = 0.08$, $p < 0.05$, waist circumference: $r = 0.11$, $p < 0.001$, WHR: $r = 0.06$, $p < 0.05$).

Table 6.3: The association between fruit and vegetable consumption in servings per day and cardiovascular risk indicators.

	Men (N=911)		Women (N=1067)	
	n	r†	n	r†
Body mass index	906	0.10**	1062	0.05
Waist circumference	909	0.07*	1051	0.06
Waist hip ratio	907	0.03	1051	0.01
Systolic blood pressure	880	–0.02	996	–0.09**
Blood glucose	863	0.07*	1037	0.04
Total cholesterol	865	0.03	1036	–0.05

† Pearson correlation coefficients.
*$p<0.05$ **$p<0.01$ ***$p<0.001$

6.5 Discussion

To guide the analysis of the association between physical activity and CVD risk indicators (body composition, blood pressure, BG and TC) in the next chapter (Chapter 7), three potential confounders or effect modifiers of that association were investigated in this chapter. The three factors were tobacco smoking, alcohol intake, and fruit and vegetable consumption. We found that tobacco smoking and alcohol intake by men were associated with both physical activity and CVD risk indicators in this sample.

Whilst the associations of tobacco smoking with physical inactivity (138), and with body weight (137) has been well documented, demonstrating a link between smoking and hypertension has been elusive (139). Previous research using smoking status as the measure of exposure has failed to demonstrate tobacco smoking is a risk factor for elevated blood pressure (75, 140-149). In our sample, the analyses presented in Appendix 6A showed that ex-smokers had higher SBP and prevalence of hypertension than current smokers. The dose-response association between smoking and hypertension was revealed when tobacco exposure was characterised by indices of cumulative exposure including number of years of smoking and pack-years. Although our analyses were restricted to men, it seems possible that the equivocal findings from previous research may be due to failure to take into account the cumulative aspects of lifetime exposure to tobacco smoking. Interestingly, adjusting for age greatly attenuated the association between cumulative indices of tobacco smoking and SBP presented in this chapter. Adjustment for age in this way is not ideal because, for smokers, age and years of smoking are interdependent. In the analyses presented in Appendix 6A, the association attenuated on adjustment for age but subsequently de-attenuated on adjustment for other factors (particularly BMI). In short, because smoking has been shown to be marginally associated with physical activity, and significantly associated with other CVD risk indicators including blood pressure in this sample, it should be treated as a potential confounder and effect modifier of the association between physical activity and CVD risk indicators.

The associations of alcohol with physical activity and with CVD risk indicators found in this sample are consistent with results from other studies. A report for a population sample of men and women from England shows that occupational activity and heavy alcohol drinking were more prevalent among manual occupational groups (150). Moreover, alcohol intake has also been shown to be positively associated with WHR (151), hypertension (133), and higher BG levels (152). Alcohol has a complex effect on blood lipids, mainly through increasing high density lipoprotein (HDL) cholesterol (153). In this sample only TC values were available and therefore the association between alcohol and the components of blood lipids could not be examined. In brief, alcohol was associated with physical activity and CVD risk indicators in this sample and should be also taken into account as a potential confounder and effect modifier to the association of physical activity and CVD risk indicators.

6.6 Conclusions

Tobacco smoking and alcohol consumption by men are potential confounders and effect modifiers of the association of physical activity and CVD risk indicators in this population-based sample.

6.7 Postscript

The analyses in this chapter have shown that tobacco use and alcohol intake by men are possible confounders and effect modifiers of the association between physical activity and CVD risk indicators in this population. In Chapter 7 to follow, the association between physical activity and CVD risk indicators will be examined, and those analyses will need to take into account the effect of smoking and alcohol use.

Appendix 6A: The association between smoking and hypertension in a population-based sample of Vietnamese men.

6A.1 Introduction

Hypertension is an important contributor to cardiovascular disease (CVD) mortality worldwide (154), and identifying its risk factors is critical for better prevention efforts. Even though tobacco smoking is a well documented risk factor for CVD, its association with hypertension remains a paradox (139). Smoking is associated with chronic low grade inflammation (155) and arterial stiffness (156, 157), which are associated with hypertension (141). Carefully controlled experiments in healthy humans have shown that smoking causes an acute increase of blood pressure (156, 158), and that smoking cessation reduces blood pressure, heart rate, and plasma epinephrine and norepinephrine concentrations among smokers (159). Nevertheless, while some population studies have shown an association between tobacco smoking status and elevated blood pressure (75, 140-142), others have failed to provide any evidence or even demonstrated a negative association (144, 147-149). In these epidemiological studies, the assessment of smoking has focused on smoking status (current, former, never). Very few studies have explored the dose-response relationship between hypertension and smoking. When dosage has been considered, it has been based on current consumption (140, 160, 161) or number of cigarettes smoked per day when smoking (162) rather than measures of lifetime dose, such as smoking duration or pack-years, which may be more relevant to hypertension risk.

Despite a rapid increase in prevalence of hypertension in developing nations of Asia in the last few decades, information on risk factors for hypertension in these populations are not available (163). Apart from a report from Indonesia (144), little is known about the association between smoking and hypertension in these populations. Whilst the smoking prevalence in Vietnamese men has been among the highest in the world (164, 165), the effect of smoking on hypertension has not been investigated in the Vietnamese population. A better understanding on this link will assist health authorities in making health promotion and intervention policies.

We had the opportunity to investigate the association between tobacco smoking and hypertension in a population-based sample of Vietnamese men.

6A.2 Methods

Sample

Participants were 25-64 year old men (n=910) who participated in a population-based survey of risk factors of cardiovascular disease and diabetes in Can Tho, Vietnam. Participants included in this analysis were all males because the number of female smokers (n= 19) in the survey was too small to allow meaningful analyses. The survey was conducted using the World Health Organization (WHO) STEPwise approach to surveillance of non-communicable disease (STEPS). Eligible subjects for this survey were selected by multistage sampling with age, sex, and urban/rural stratification. Details about the survey have been published elsewhere (55). Informed consent was obtained from participants. The study was approved by the Ethics Committee of Can Tho University of Medicine and Pharmacy. Data collection was carried out from July to November 2005.

Measurements

STEPS survey measures included demographic characteristics, behavioural risk factors (smoking, alcohol consumption, fruit and vegetable consumption, and physical activity), physical characteristics (weight, height, waist and hip ratio, and blood pressure), fasting blood glucose, and total cholesterol. All measurements were performed in accordance with the WHO STEPS protocols (67).

Tobacco smoking was assessed as a component of the STEPS questionnaire. Current smokers were those who reported that they currently smoked any tobacco products such as cigars, cigarettes or pipes either on a daily or non-daily basis. Current daily smokers were asked to provide information on the age they commenced smoking and the quantities of tobacco they smoked. Ex-smokers were those who previously smoked daily. Ex-smokers were asked to recall the ages at which they started and stopped smoking. Smokeless tobacco use and passive smoking were also recorded. The questionnaire was translated into Vietnamese and back-translated to ensure the appropriate meaning of each item was retained.

After participants had rested for at least five minutes, blood pressure was measured at the mid-point of the right arm using an Omron T9P digital automatic blood pressure monitor by trained staff. Two blood pressure readings were obtained for all participants. In accordance with the STEPS protocols in 2005, a third reading was taken if there was a difference of more than 25mmHg for systolic blood pressure (SBP) or 15mmHg for diastolic blood pressure (DBP) between the first two readings (this was required for only 24 men). The means of all measures were used. Substituting the mean of the two closest measures for the 24 men with three readings had a negligible impact on our results.

Statistical methods

Data were coded and presented according to the WHO guidelines (67). Smoking duration in years was calculated as current age (current smokers) or age at quitting (ex-smokers) less the age commenced smoking. Pack-years of smoking was calculated by multiplying the number of years spent smoking by the number of cigarettes smoked daily, divided by 20 (166). Hypertension was defined as SBP $\geq$ 140 mmHg and/or DBP $\geq$ 90 mmHg, or taking medication for hypertension. Only 29 men were taking medication for hypertension, and of them 19 had SBP $\geq$ 140 mmHg and/or DBP $\geq$ 90 mmHg. Body mass index (BMI) was calculated as body weight divided by the square of height (kg/m^2). Poisson regression was used to estimate prevalence ratios (PR) and 95% confidence intervals (CI). In the multivariable analyses, associations between smoking and hypertension were adjusted for age, BMI, and alcohol intake. All analyses were performed using complex survey methods provided by STATA software version 10.

6A.3 Results

Table 6A.1 presents characteristics of study participants. Hypertensive men were older, consumed more alcohol, and had higher BMI than their normotensive counterparts. The prevalence of smoking in this sample has been presented elsewhere (55). The proportions of current smokers, ex-smokers, and never smokers were 67.8% (631/910), 13.0% (130/910), and 19.2% (149/910), respectively. On average, men in this sample smoked for 15.5 years and their lifetime cigarette consumption was 10.2 pack-years.

Table 6A.1: Characteristics of study participants (n=910).

	Normotensive (n=590)		Hypertensive (n=320)		*p value*
	Mean	± 95%CI*	Mean	± 95%CI*	
Age	38.1	± 0.7	44.5	± 1.3	<0.001
Years at school	7.5	± 1.1	7.1	± 1.2	0.367
Alcohol (standard drinks)	7.1	± 1.2	11.6	± 2.9	0.002
Fruit + vegetable intake‡	4.1	± 0.5	3.7	± 0.3	0.097
Physical activity§	106.4	± 29.3	106.4	± 29.3	0.999
Weight (kg)	55.4	± 3.3	58.3	± 2.6	0.097
Body mass index (kg/m^2)	21.0	± 0.8	22.0	± 0.7	0.044
Waist	73.9	± 2.2	78.1	± 2.5	0.005
Waist-hip-ratio	0.84	± 0.1	0.87	± 0.1	<0.001

* 95% confidence interval.
† Number of standard drinks consumed in the last 7 days.
‡ Serving per day.
§ Moderate and vigorous physical activity in Metabolic Equivalent Task unit (MET)-hour per week.

Table 6A.2 presents the associations between smoking and hypertension. Current smokers as a group had only a marginally higher prevalence of hypertension than never-smokers. Ex-smokers had a higher prevalence of hypertension than either never smokers (p=0.03 adjusted for age, BMI and alcohol consumption) or current smokers (PR= 1.67, 95%CI: 1.25-2.23, p<0.01 similarly adjusted). However, when smokers were categorised by their years of smoking or by the lifetime number of cigarettes smoked, dose-response relationships with hypertension were revealed. Men who smoked for longer duration or had higher lifetime cigarette consumption were at significantly higher risk of hypertension. These trends persisted after adjusting for BMI and alcohol intake. Adjusting for waist circumference instead of BMI resulted in only minor changes to these estimates (data not shown).

Table 6A.2: Association between measures of smoking history and current hypertension among Vietnamese men, 2005.

	Years*	n/N	Model 1† PR‖ (95% CI)¶	Model 2‡ PR‖ (95% CI)¶	Model 3§ PR‖ (95% CI)¶
Smoking status					
Never smokers	0	47/149	1.00	1.00	1.00
Ex-smokers	16.5	65/130	1.80 (1.08-2.98)	1.93 (1.14-3.27)	1.81 (1.07-3.06)
Current smokers	20.0	207/630	1.06 (0.64-1.74)	1.17 (0.73-1.88)	1.08 (0.70-1.68)
Smoking duration					
Never smokers	0	47/149	1.00	1.00	1.00
≤ 15 years	9.9	34/168	0.97 (0.59-1.59)	1.07 (0.64-1.79)	1.01 (0.62-1.65)
15-30 years	21.7	111/323	1.29 (0.72-2.31)	1.45 (0.85-2.48)	1.37 (0.83-2.24)
30+ years	35.7	120/240	1.48 (0.86-2.57)	1.70 (1.04-2.77)	1.52 (0.95-2.44)
p for trend			*p=0.13*	*p=0.03*	*p=0.05*
Lifetime cigarettes**					
Never smokers	0	47/149	1.00	1.00	1.00
<10 pack-years	13.8	43/176	0.90 (0.52-1.57)	1.02 (0.60-1.73)	0.96 (0.59-1.56)
10-20 pack-years	22.0	68/218	1.09 (0.61-1.92)	1.27 (0.74-2.18)	1.17 (0.72-1.91)
20+ pack-years	29.6	86/196	1.30 (0.84-2.01)	1.50 (1.00-2.26)	1.34 (0.94-1.91)
p for trend			*p=0.09*	*p=0.02*	*p=0.03*

* Mean years of smoking.
† Adjusted for age.
‡ Adjusted for age and body mass index.
§ Adjusted for age and body mass index, and alcohol consumption.
‖ Prevalence ratio.
¶ 95% Confidence Interval.
** Excludes ex-smokers, who did not provide information on numbers of cigarettes smoked per day.

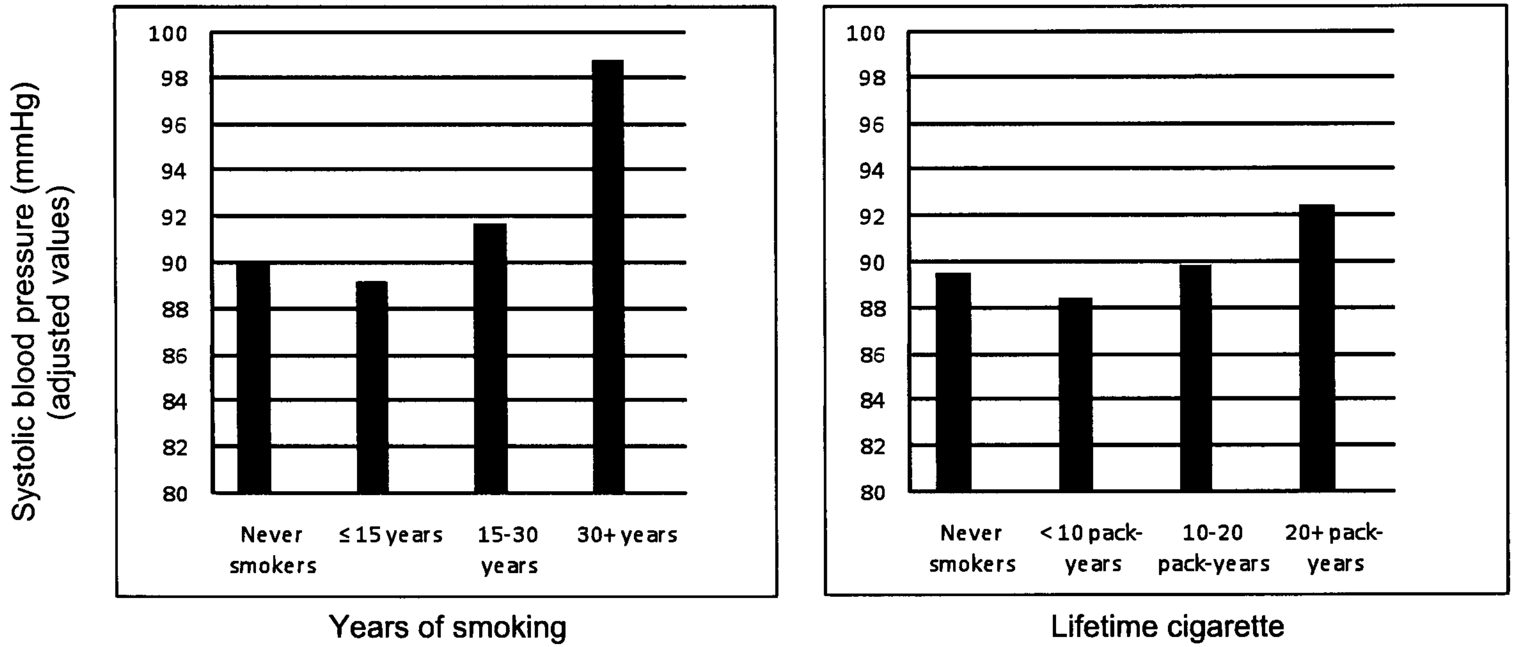

Figure 6A.1: Mean of systolic blood pressure by smoking duration and lifetime cigarette consumption after adjusting for age, body mass index, and alcohol intake. Excluded from analyses were 29 men who were taking medication for hypertension.

Associations between smoking and blood pressure were similar to those between smoking and hypertension. Ex-smokers had higher systolic and diastolic blood pressure than never smokers (see Table 6A.3). The mean SBP of participants by duration of smoking and lifetime cigarette consumption are depicted in Figure 6A.1. There was a trend of increasing SBP with increasing years of smoking (p=0.02 adjusted for age, BMI and alcohol intake). For lifetime cigarettes, the trend was not significant (p=0.25 similarly adjusted).

Table 6A.3: Characteristics of study participants categorised by smoking status.

	Never smokers (n=149)		Ex-smokers (n=130)		Current smokers (n=631)	
	Mean	± 95%CI*	Mean	± 95%CI*	Mean	± 95%CI*
Age	37.2	± 1.9	42.6	± 1.8	40.0	± 0.7
Household income (USD/year)	2332	± 1139	1812	± 628	1568	± 239
Years at school	9.5	± 1.9	7.6	± 1.2	6.9	± 0.8
Alcohol (standard drinks)	3.6	± 1.3	7.8	± 4.3	9.7	± 2.5
Fruit + vegetable intake‡	4.4	± 0.3	4.0	± 0.6	3.9	± 0.3
Physical activity§	115.9	± 45.1	87.6	± 42.8	106.3	± 25.6
Sitting time (hours/day)	3.8	± 0.9	4.0	± 0.5	3.8	± 0.8
Weight (kg)	58.3	± 2.4	57.0	± 2.6	55.4	± 1.9
Body mass index (kg/m^2)	22.1	± 1.1	21.3	± 0.7	21.0	± 0.7
Waist (cm)	76.7	± 2.7	76.8	± 2.5	74.2	± 2.0
Waist-hip-ratio	0.85	± 0.01	0.86	± 0.01	0.84	± 0.02
Systolic blood pressure‖	126.9	± 2.6	135.4	± 5.0	127.5	± 2.2
Diastolic blood pressure‖	78.4	± 2.0	84.8	± 3.6	79.1	± 2.2

* 95% confidence interval.
† Number of standard drinks consumed in the last 7 days.
‡ Servings per day
§ Moderate and vigorous activity in Metabolic Equivalent Task unit (MET)-hour per week.
‖ mmHg

To investigate possible reasons for the higher blood pressure among ex-smokers, Table 6A.3 presents means of possible explanatory factors for participants categorised by smoking status. Ex-smokers were older, less physically active, and spent more time sitting than the other two groups. In additional analyses, sitting time was found to be associated with hypertension (p=0.04) whilst physical activity was not (p=0.54). However, adjusting for physical activity and sitting time did not alter the relationship of smoking status and hypertension with the mean SBP for those who were not on medication for hypertension (this excluded 29 men who were taking anti-hypertensive medication) and prevalence of hypertension remaining higher for ex-smokers (data not shown). Adjusting for moderate intensity activity instead of total physical activity did not change the results either (data not shown).

6A.4 Discussion

This study examined the association between smoking and hypertension in a population-based sample of Vietnamese men. We found that smoking duration and higher lifetime cigarette consumption were each associated with a higher risk of hypertension in a dose-response fashion in this male population with high smoking prevalence and independent of age, BMI, and alcohol consumption. However, current smokers were not at higher risk of hypertension than never smokers; rather, ex-smokers were more likely to be hypertensive than either never or current smokers.

A link between tobacco smoking and blood pressure is biologically plausible and cigarette smoking has been observed to cause acute increases in blood pressure in experimental settings (158). Cigarette smoking increases sympathetic outflow (167), possibly through an increased release and/or reduced clearance of catecholamines at the neuroeffector junctions (168). In addition, smoking is associated with chronic low grade inflammation (155) and arterial stiffness (156, 157), which are associated with hypertension (141).

In the context of lung cancer, Doll and Peto (169) have emphasised the importance of quantifying the dose of tobacco exposure in terms of years of smoking and total number of cigarettes smoked. This is in accordance with the principle of toxicology that the dose of exposure (determined by frequency of exposure, length of exposure, and other factors) determines the response of the organism (170). Experimental studies have shown that the number of cigarettes consumed is associated with acute increases in blood pressure following a dose-response pattern (159). Furthermore, smoking high-nicotine cigarettes has been shown to induce a higher and more sustained elevation of blood pressure than smoking low-nicotine cigarettes (171). In epidemiological studies, where the chronic effects of past smoking are investigated, cigarette smoking has been associated with dose-related impairment of endothelium-dependent arterial dilation (172), and more pack-years of smoking is associated with progression of atherosclerosis (173). In this study, a clear association between smoking and blood pressure emerged once dosage was taken into account. Men who smoked for longer duration or consumed more pack-years of cigarettes had a higher risk of hypertension after adjusting for age, BMI, and alcohol consumption. It is possible that the different results observed for smoking status and duration or pack-years may explain some of the equivocal findings of previous epidemiological studies which focused on smoking status as the measure of tobacco exposure and did not take into account the duration of smoking and lifetime cigarette consumption (75, 140-149).

A higher prevalence of hypertension among ex-smokers has been reported in previous studies (174, 175). In each study, weight gain following smoking cessation was ruled out as a potential explanation. Likewise, adjusting for BMI did not change the association observed in this study. While ex-smokers did less physical activity and tended to spend more time sitting, adjusting for physical activity and sitting time did not alter the results. The possibility of reverse causality, whereby ex-smokers may have quit because they were told they had hypertension, cannot be ruled out as potential explanation for the higher prevalence of hypertension observed among ex-smokers in this study.

A key strength of this study was its use of a representative sample, recruited with a high response proportion. The use of WHO standardised protocols, intensive training of data collection staff, pre-study testing of procedures, and the close supervision of staff during data collection, all highlight the attention that was paid to minimising avoidable sources of measurement error. The availability of various measures of smoking and covariates including demographic characteristics, alcohol use, fruit and vegetable consumption, physical activity, and body composition allowed us to investigate the association between smoking and hypertension thoroughly. The low proportions of treated hypertensive men may have enabled us to better estimate the association of blood pressure with smoking.

This study has some limitations. Firstly, we did not measure quantity of tobacco use for ex-smokers, and their pack-years of smoking could not be calculated. However, ex-smokers comprised only a small proportion (17%) of ever smokers. Secondly, we also did not have an objective measure of dietary sodium. The indirect indicators of salt intake measured by the STEPS questionnaire did not show any association with blood pressure, but measurement of salt intake by questionnaire is problematic (176).

Failure to adjust for an accurate estimate of sodium intake may have influenced the findings of this study. Lastly, the analyses of this study were restricted to men because very few of the women in our sample were smokers. Smoking has deleterious effects for women (177), and plausibly the dose-response effects observed for men would occur for women as well, but this remains to be investigated in a population with a higher prevalence of female smokers.

In summary, lifetime smoking duration and intensity (pack-years) were each associated with hypertension in a dose-response manner in this population-based sample of Vietnamese men.

Chapter 7: Physical activity and its association with cardiovascular risk indicators in Vietnam.

7.1 Preface

Previous chapters have presented issues in the measurement of physical activity in the Vietnamese population (Chapters 3-5), and identified smoking and alcohol consumption as behavioural risk factors that are associated with physical activity and cardiovascular disease (CVD) risk indicators – body composition, blood pressure, blood glucose (BG), and total cholesterol (TC) in this sample from the Mekong Delta region (Chapter 6). The association between physical activity measured by the Global Physical Activity Questionnaire (GPAQ) and CVD risk indicators are examined in this chapter, taking into account the effects of smoking and alcohol intake. The material reported has been submitted for publication in a peer-reviewed journal (59).

7.2 Introduction

With rapid economic development over the last few decades, many developing countries in Asia have experienced a dramatic transition in disease patterns, with the burden of non-communicable diseases outweighing traditional communicable diseases (4, 178). The increasing prevalence of non-communicable diseases may be due to lifestyle changes that accompany economic development, including more sedentary forms of work and leisure (179). However, whilst there is some information on physical activity participation at community levels in these populations (26, 180-184), little is known about whether the relationship between physical activity and chronic diseases in these populations is similar to that observed in developed countries, where the distribution of confounders and effect modifiers of this association may be quite different. Furthermore, the distinctive types of leisure and work activity performed by people in developing countries may have different health benefits. A better understanding of these issues would assist public health agencies in these countries in formulating policies related to physical activity promotion and chronic disease prevention.

Previous studies in developed populations have shown that physical activity is an important determinant of cardiovascular disease (CVD) (185-188). In less industrialised countries of Asia, however, this association has been less clearly documented. For example, in an urban Chinese population, commuting and leisure activity was found to be favourably associated with CVD risk factors, but that more than 60 minutes of such activity was associated with high blood pressure (189). Similarly, men who were physically inactive at recreation were less likely to be overweight or obese in a study of residents of Ho Chi Minh City (HCMC) (190). Also, leisure activity was positively related with antioxidant capacity and insulin sensitivity, but heavy occupational physical activity was found to be associated with an unfavourable lipid profile in a sample of female workers in Guangdong (191). This is in contrast to findings from another Chinese population-based study that low levels of work-related physical activity were a predictor of hypertension (192). Likewise, physical inactivity was associated with components of metabolic syndrome and with coronary artery disease in a study of an urban population of India (183). While the reasons for these conflicting results remain obscure, further investigation is clearly needed to better understand the relationship between different types of physical activity and CVD in developing Asian populations.

In this study, we examined participation in leisure and work physical activity and their relative contributions to total moderate and vigorous activity in a population-based Vietnamese sample. The primary objective was to investigate the associations between physical activity and CVD risk factors and the extent to which these associations varied according to activity type.

7.3 Methods

Sample

This study utilised data from a population-based survey of risk factors for CVD in Can Tho in the Mekong Delta, southern Vietnam. The survey was conducted using the World Health Organization (WHO) STEPwise approach to non-communicable disease (STEPS). The sample was selected by multi-stage sampling of 25-64 year old Can Tho residents and was stratified by age, sex, and urban/rural location. The response rate was 73.7% (1978/2683). All participants provided informed consent. The study was approved by the Ethics Committee of Can Tho University of Medicine and Pharmacy. Data collection was carried out from July to November 2005. Details of this survey have been reported elsewhere (55, 58).

Measurements

The STEPS survey included measures of behavioural risk factors (tobacco smoking, alcohol consumption, fruit and vegetable consumption, physical activity), physical characteristics (weight and height, waist and hip circumference, blood pressure), and blood chemistry (fasting blood glucose (BG) and total cholesterol (TC)) (193). The survey questionnaire was translated and back-translated by independent translators, and was administered face-to-face by trained interviewers. All measurements were performed according to WHO STEPS protocols (67, 193).

Physical activity was measured by the Global Physical Activity Questionnaire (GPAQ) –a component of the STEPS questionnaire (193). GPAQ gathers information on the frequency and duration of moderate and vigorous physical activity in a typical week. Physical activities of at least 10 minutes duration were reported for each domain (work, transport, and leisure). Work physical activity was defined as "things you have to do such as paid or unpaid work, household chores, harvesting food, fishing or hunting for food, or seeking employment". Transport physical activity included self-powered commuting activities such as walking and bicycling. Leisure activity was "activity you do for recreation, fitness or sports". Moderate intensity activity was defined as activity that "makes you breathe somewhat harder than normal". Vigorous intensity activity was defined as activity that "makes you breathe a lot harder than normal". Local examples of relevant activities were used to assist participants. Participants also reported time spent in sedentary behaviours (including sitting at a desk, visiting friends, reading, and watching television) during the past week. The reliability and validity of GPAQ in the Vietnamese population has been reported previously (56).

Statistical methods

Physical activity data were coded and scored according to WHO guidelines (67, 193). Metabolic Equivalent Task (MET)-weighted hours of activity were calculated by multiplying hours of activity with the MET values provided in the guidelines (moderate activity was assigned a MET value of 4 and vigorous activity a MET value of 8). Physical activity data were right skewed and are thus presented as medians with 25^{th} and 75^{th} percentiles. Partial Spearman correlation coefficients were used to examine the associations of physical activity with body composition, systolic blood pressure (SBP), BG and TC. Associations between physical activity and CVD risk factors were adjusted for age, smoking, and alcohol consumption.

Because both physical activity level and cardiovascular risk are known to change with age, we looked for effect modification by age and found that it modified the association between sitting time and body composition in women. Therefore, this association is presented across age strata (< 45 years, ≥ 45 years). In addition, GPAQ uses a typical week as a reference period and has been shown to have different reliability and validity among study participants with stable and unstable work patterns (56). Therefore, we also stratified participants by their work patterns.

7.4 Results

Table 7.1 presents the average time spent in different intensities and domains of physical activity for men and women. Moderate intensity activity was the main contributor to total activity, especially among women. There were 77% of men and 93% of women who reported no vigorous activity. For both sexes, work physical activity accounted for about 80% of total moderate and vigorous intensity activity, whilst leisure activity accounted for only 2.7% of the total for men and 1.8% for women.

Table 7.1: Average time spent on physical activity of study participants in Can Tho, Vietnam, 2005.

	Men (N=910)				Women (N=1066)			
	Mean	Median	25th*	75th†	Mean	Median	25th*	75th†
Intensity (hrs/w)								
Moderate	15.1	6.0	0	24.5	15.2	4.0	0	24.5
Vigorous	5.1	0	0	0	1.3	0	0	0
Total	20.0	10.5	0.6	35.0	16.4	4.7	0	28.0
MET-hours/ week‡								
Work	84.4	9.3	0	144.0	57.7	0	0	84.0
Transport	13.3	2.0	0	16.0	11.9	4.7	0	14.0
Leisure	2.7	0	0	0	1.3	0	0	0
Total	99.9	49.0	2.3	168.0	70.5	18.7	0	112.0
Sitting (hours/day)	3.6	3.0	2.0	5.0	3.2	2.5	1.5	4.0

* 25th percentile.
† 75th percentile.
‡ Total MET-weighted hours of moderate and vigorous activity in a typical week.

The majority of men (92%) and women (95%) reported no leisure activity at all. Participants who reported more work activity had somewhat less leisure activity. The correlations between work and leisure activity were r = –0.04 for men and r = –0.02 for women. Despite reporting more time in moderate and vigorous activities, men in this sample spent slightly more time sitting than their female counterparts.

Table 7.2 presents associations between domain-specific physical activity and measures of body composition after adjusting for age. For men, total moderate and vigorous activity was inversely associated with BMI, waist circumference and waist to hip ratio (WHR) and sitting time was positively associated with these indicators.

Table 7.2: Associations of physical activity in MET-hours per week and sitting time with measures of body composition in Can Tho, Vietnam, 2005.

	Adjusted for age				Adjusted for age, smoking, alcohol†	
	Men		Women		Men	
	n	r‡	n	r‡	n	r‡
Work						
BMI	903	-0.14^{***}	1054	−0.02	865	-0.15^{***}
Waist	906	-0.20^{***}	1043	−0.03	868	-0.20^{***}
WHR	904	-0.18^{***}	1043	−0.01	866	-0.18^{***}
Transport						
BMI	903	-0.08^{*}	1058	−0.04	865	-0.08^{*}
Waist	906	-0.12^{***}	1047	−0.06	868	-0.12^{***}
WHR	900	-0.10^{**}	1047	−0.02	866	-0.10^{**}
Leisure						
BMI	906	0.06	1060	0.04	868	0.05
Waist	909	0.06	1049	0.03	871	0.05
WHR	907	0.01	1049	−0.01	869	0.01
Total MET-hr/w						
BMI	900	-0.16^{***}	1046	−0.01	862	-0.17^{***}
Waist	903	-0.22^{***}	1035	−0.02	865	-0.22^{***}
WHR	901	-0.20^{***}	1035	0.01	863	-0.20^{***}
Sitting (hrs/d)						
BMI	906	0.10^{**}	1060	0.06	868	0.10^{**}
Waist	909	0.11^{**}	1049	0.09^{**}	871	0.11^{**}
WHR	907	0.10^{**}	1049	0.08^{**}	869	0.09^{*}

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

† These analyses were performed for men only because there were very few women who smoked or drank.

‡ Partial Spearman correlation coefficients.

BMI body mass index; WHR waist hip ratio.

The main contributor to the associations between total activity and body composition was work activity. Leisure activity was not associated with body composition. For women, sitting time was associated with waist circumference and WHR whilst none of the indices of physical activity were associated with body composition. Adjustment for smoking and alcohol consumption in addition to age resulted in negligible changes.

Associations between sitting time and body composition measures were stronger for women aged 45 or older than for younger women, but were more similar among men of the two age groups (Figure 7.1). In further analyses, for women age 45 years or more, the associations between sitting time and body composition remained significant after adjusting for total physical activity (BMI r = 0.12, waist circumference r = 0.13, WHR r = 0.14).

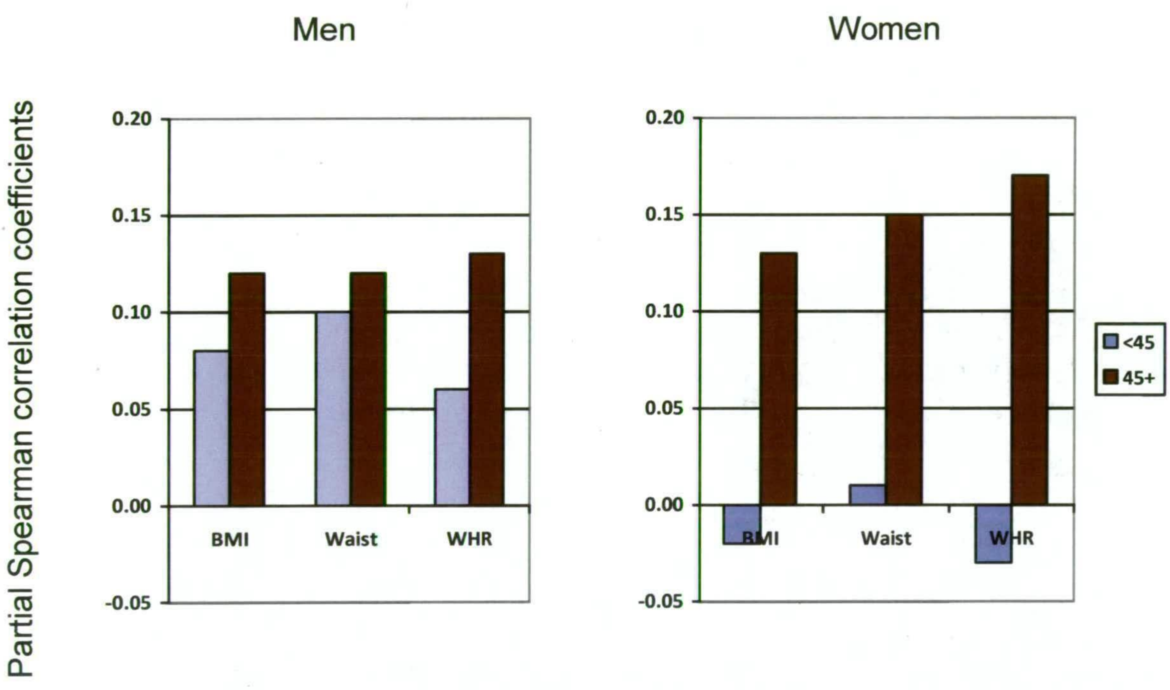

Figure 7.1: Partial Spearman correlation coefficients between sitting time in hours per day and body fatness indices adjusted for age in Can Tho, Vietnam 2005. BMI body mass index, WHR waist to hip ratio.

Table 7.3 presents associations between physical activity and SBP, BG and TC after adjusting for age. For men, all measures of physical activity were associated with TC except leisure activity. The main contributor to the association of total physical activity with TC was work activity. In addition, transport activity was associated with BG. Adjusting for smoking and alcohol intake in addition to age, resulted in negligible changes. Leisure activity was not associated with any CVD risk factors even after further adjustment for work activity (range of correlations r = –0.03 to r =

0.05, data not shown). For women, total activity was inversely associated with TC, and this association was again driven by work activity.

Table 7.3: Associations of physical activity in MET-hours per week and sitting time with cardiovascular risk indicators in Can Tho, Vietnam, 2005.

	Adjusted for age				Adjusted for age, smoking, alcohol†	
	Men		Women		Men	
	n	r‡	n	r‡	n	r‡
Work						
SBP	877	0.04	989	-0.01	839	0.03
BG	860	-0.04	1029	0.01	824	-0.04
TC	862	-0.13***	1028	-0.06*	826	-0.12***
Transport						
SBP	877	-0.02	992	-0.03	839	-0.02
BG	860	-0.07*	1034	0.01	824	-0.07*
TC	862	-0.09*	1033	-0.04	826	-0.08*
Leisure						
SBP	880	0.02	993	-0.04	842	0.02
BG	863	-0.01	1034	0.05	827	-0.01
TC	865	-0.02	1033	-0.01	829	-0.03
Total MET-hr/w						
SBP	874	0.02	980	-0.04	836	0.01
BG	857	-0.07*	1021	0.02	821	-0.07*
TC	859	-0.17***	1020	-0.07*	823	-0.17***
Sitting time						
SBP	880	0.03	993	-0.08**	842	0.05
BG	886	0.06	1034	0.06	827	0.05
TC	865	0.08*	1033	-0.01	829	0.07*

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

† These analyses were performed for men only because there were very few women who smoked or drank.

‡ Partial Spearman correlation coefficients.

SBP systolic blood pressure; BG blood glucose; TC total cholesterol.

There were no significant differences in CVD risk factor estimates for those with some leisure activity compared to those with no leisure activity with the exception of higher BMI (p = 0.04) and larger waist circumference (p = 0.03) values observed among men with some leisure activity.

In further analyses, the association between total physical activity and TC was attenuated but remained significant after adjusting for BMI in addition to age (r = –0.12 for men and r = –0.07 for women).

When participants were grouped into those with stable and unstable work patterns, physical activity was significantly associated with body composition for men with stable work patterns (the correlations between total activity and BMI, waist circumference, and WHR were $r = -0.17$, $r = -0.24$, and $r = -0.23$, respectively). The corresponding correlations for men with unstable work patterns were much lower and did not reach statistical significance (BMI $r = -0.13$, waist circumference $r = -0.14$, WHR $r = -0.09$). There were no significant associations between physical activity and body composition in women when participants were grouped in this way (range of correlations $r = -0.01$ to $r = 0.01$, data not shown). The associations of total activity with CVD risk indicators were generally higher for persons with stable work patterns (men: SBP $r = 0.02$, BG $r = -0.09$, TC $r = -0.17$; women: SBP $r = 0.05$, BG $r = 0.03$, TC $r = -0.09$) than for persons with unstable work patterns (men: SBP $r = 0.04$, BG $r = -0.01$, TC $r = -0.15$; women: SBP $r = -0.06$, BG $r = 0.03$, TC $r = -0.04$).

7.5 Discussion

This study presents information on physical activity participation levels and their associations with CVD risk factors in a population-based Vietnamese sample, and this is the first report of physical activity in the population of the Mekong Delta. We found that leisure activity constituted less than 5% of total moderate and vigorous intensity activity in this population and was not associated with CVD risk factor levels. Work activity, in contrast, constituted 80% of total activity and was associated with body composition, BG and TC for men and with TC for women. Our findings provide some confirmation that consistent evidence of an inverse association between physical activity and CVD risk in Western populations could be extrapolated to Asian populations irrespective of different activity patterns.

Significant protective associations were observed between work physical activity and CVD risk factors, particularly among men. While these results contrast with reports from some neighbouring populations (191, 192), they are biologically plausible and underline the potential importance of work-related sources of physical activity in preventing CVD in this population.

Leisure activity was not associated with improved CVD risk factor profiles in this study, even after adjusting for a number of potential confounding factors. This is in contrast with findings by previous studies in developed populations (187-189, 194) that leisure activity is associated with reduced CVD risk. A previous study in the population of HCMC (190) shows that men who were inactive during their leisure time were less likely to be obese, but this study did not take into account the effect of work activity, which was the major contributor to total activity in that sample (26). In this study, as in the HCMC sample, leisure time activity formed only a small part of total activity. Furthermore, the participants of this sample who reported more leisure activity had less work activity. The higher BMI and waist circumference among men who reported some leisure activity relative to those who reported no leisure activity were also consistent with this. However, adjusting for work activity in addition to other covariates did not change the results. A more likely reason is that the leisure activity reported in this sample may have been too low in intensity or too fragmented (less than 10 minute duration) to be captured by GPAQ. Moreover, when leisure activities with at least moderate intensity were reported, total MET-values of those activities constituted 2.7% of total activity for men and 1.8% of total activity for women.

Stronger associations between physical activity and CVD risk factors were observed for men than for women in this study. This concurs with our previous findings that GPAQ assesses physical activity with less accuracy for women than for men (56). Similarly, a study conducted in Japanese women (195) using the Minnesota Leisure Time Physical Activity Questionnaire (187) also reported a weak association between physical activity and BMI. Although most studies in Western populations have shown more clearly that physical activity is inversely associated with body composition (196) and all cause mortality (197) in both men and women, physical activity measured by questionnaires was not associated with CVD morbidity and mortality in women in a report from Framingham (198). The generally weaker associations for women compared to those for men suggest that traditional physical activity questionnaires may not be able to comprehensively capture physical activity of women possibly because it is too fragmented and/or low in intensity, which was the case for the women of this study. For example, 57% of women in this study but only 21% of men had unstable work patterns. Possibly as a results of underreporting due to this, the median physical activity of women was less than half that of men when measured by GPAQ but almost identical when measured by three other methods.

In agreement with our previous report that GPAQ is more reliable and valid for participants with stable work patterns than for those with unstable work patterns (56), this study observed that the correlations between physical activity and body composition were higher for those with stable work patterns than for those with more variable work activities, particularly among men. The associations of physical activity and CVD risk indicators, though modest, were also somewhat stronger for those with stable work patterns. This consistency highlights the need of a modification of GPAQ as suggested in the previous report (56) to improve its measurement property in subjects with variable activity.

In this sample, the associations between sitting time and body composition was stronger for women aged 45 years or more than for their younger counterparts, and persisted after adjustment for physical activity. This suggests that sedentary behaviour associates with increased CVD risk through a pathway other than by compromising the time available for physical activity. Moreover, this mechanism appears to be stronger for women of older age.

The mean total activity levels (in MET-hours per week) reported by participants in this study (men 99.9, women 70.5) are higher than those reported for a Malaysian national sample (men 69.1, women 69.6) (180). On the other hand, the total hours per week of activity (men 20.0, women 16.4) reported in this study are similar to those of a population sample of American Samoans (men 25.7, women 12.6) (199). and are much lower than those reported for a Bangladesh national sample (men and women combined: 46.8) (200), and for a Myanmar population sample from Yangon (rural: men 76.9, women 58.3, urban: men 53.8, women 46.7) (181, 201). All these surveys used the GPAQ from the WHO STEPS instrument, and the differences are unlikely to be due to measurement issues. The Malaysian population is at a more advanced stage of modernisation, whereas many Vietnamese occupations still depend on physical labour. In contrast, Bangladesh and Myanmar are at relatively lower ranges of development (202). and people may depend more on manual work and thus are more physically active.

This study broadly describes the pattern of physical activity participation in the rural population of Vietnam. At this early stage of industrialisation, a significant proportion of total activity engaged in by the Vietnamese adults in this sample was performed as part of their work in and outside of the home, much of which still consists of manual labour. Leisure activity participation, on the other hand, was minimal. Overall, regardless of activity type, participants reported a reasonable level of physical activity. However, it may be anticipated that further modernisation and urbanisation will lead to reduced levels of work-related activity (24). As this occurs, an important challenge will be to replace work activity with other forms of physical activity. In order to avoid the substantial declines in total physical activity that have been associated with urbanisation in other populations (23), appropriate interventions will be needed to facilitate this transition.

This study benefits from having a population-based sample that was recruited with a high response rate. The ranges and quartiles of physical activity levels as well as the CVD risk indicators in the sample are likely to accurately reflect the ranges in the target population. The use of internationally standardised protocols and the careful training of data collection staff ensure the accuracy of the data obtained. The comprehensive measure of physical activity across all domains, and the availability of data on other behavioural risk factors of CVD, allowed us to examine the associations and adjust for several potential confounders.

There are some limitations in this study. Firstly, the use of GPAQ to measure physical activity has been shown to have limitations, especially when used in women (56). Whilst the use of a more accurate measurement of physical activity by objective instruments would be ideal, such information has not been obtained in population-based settings in developing countries of Asia. The self-report measurements of physical activity by questionnaires provide important information to facilitate the preliminary understanding of the complex association between physical activity and CVD in these populations. This will in turn give more insights on how physical activity should be assessed in these populations. Secondly, we did not measure other important risk factors of CVD including total energy intake, dietary salt and saturated fat intake. Failing to adjust for these factors may have influenced the findings.

7.6 Conclusions

In summary, physical activity was associated with body composition, BG and TC for men and with TC for women in this population-based Vietnamese sample. The associations were driven by work activity, which constituted 80% of total moderate and vigorous activity.

7.7 Postscript

The analyses in this chapter have shown that physical activity was associated with CVD risk indicators in this population-based Vietnamese sample, and that work activity was the main contributor in those relationships. These findings underscore the importance of work activity, and re-emphasize that work activities need to be measured accurately to allow detailed interpretation of the association between physical activity and CVD risk indicators.

Chapter 8: Summary

8.1 Background and aims of the thesis

Since the implementation of the economic reform in 1986, Vietnam has been recognised as one of the best performers internationally in terms of economic development, improvement in living standards and poverty reduction (1). To illustrate, the country's Human Development Index rose from 0.56 in 1985 to 0.73 in 2005 (203). As part of this transition, the health of the population has also undergone substantial transforms. The infant mortality rate dropped from 82/1000 in 1978 to 38/1000 in 1998 (204). Life expectancy has risen from 64 years for men and 68 years for women in 1990 to 70 years for men and 75 years for women in 2007 (4).

In addition to these positive changes, the economic advancement has also had a negative impact on the health of the Vietnamese population. In 2001, 66% of deaths in the country were due to NCD as compared to 42% in 1986 (3). Moreover, this proportional rise in NCD mortality may not simply be due to the decrease in communicable disease (CD) mortality. Although there have been no data from Vietnam, research in other developing countries has shown that people in these countries also die from NCD at a much younger age than their counterparts in developed nations (5). In Vietnam, the premature NCD deaths impose a "double burden" on the health care system of the country.

The factors that underpin the rise in NCD mortality in Vietnam are likely to be the lifestyle changes associated with industrialisation and modernisation. One of these changes is a probable decrease in population levels of physical activity, an established determinant of NCD in Western populations (186). The limited data from Vietnam (13, 26) do not allow a trend of physical activity levels over time to be identified. However, there are reasons to suspect that some decrease in population levels of physical activity has occurred. The population has become more dependent on motorised transport and modern household appliances (25). Furthermore, the mechanisation of industries such as farming (25) may have reduced manual labour in the workplace. Regular surveillance of physical activity of the population is critical to inform policy makers about emerging health risks and to evaluate interventions to promote physical activity as part of the prevention and control strategy for NCD.

To facilitate physical activity monitoring in Vietnam, it is crucial to have a reliable, valid, and locally relevant survey instrument. There is a substantial body of knowledge on the measurement of physical activity, but most of it is based on research conducted in populations from Western countries. Little is known about measuring physical activity in the Vietnamese population, particularly for rural dwellers whose activities are likely to be different from those of people in developed countries. Instruments for measuring physical activity need to be locally adapted and critically tested before widespread use of them can be made in Vietnam.

The principal aim of this thesis was to evaluate the reliability and validity of a range of methods of measuring physical activity in the Vietnamese population. A secondary aim was to investigate the prevalence of physical inactivity and other NCD risk factors in a population-based sample of residents from rural Vietnam.

8.2 Methods

The data presented in this thesis came from a population-based survey of risk factors for NCD among residents of the province of Can Tho in the Mekong Delta, southern Vietnam. The survey used the WHO STEPwise approach to surveillance of non-communicable diseases (STEPS) methodology and aimed to present prevalence of NCD risk factors of the population. Participants (n=1978) were 25-64 year old residents of Can Tho. They were selected by multistage sampling with age, sex, and rural/urban stratification. The measurements of the survey included behavioural risk factors (smoking, alcohol consumption, fruit and vegetable intake, and physical activity), anthropometry, blood pressure, fasting blood glucose (BG) and total cholesterol (TC). Participants were invited to attend a clinic after an overnight fast. The clinic was held in their local commune. Behavioural risk factors were measured by questionnaire administered in face-to-face interviews. Physical activity was measured using the Global Physical Activity Questionnaire (GPAQ), a component of the STEPS questionnaire. All measurements were performed in accordance with internationally standardised protocols. Data collection occurred from July to November 2005.

A sub-sample (n=251) of survey participants was randomly selected to be involved in studies evaluating several methods of measuring physical activity including face-to-face interviews using GPAQ (test and retest after three weeks) and the International Physical Activity Questionnaire – IPAQ (test and re-test after three weeks), seven days of pedometer wear, and physical activity record (PAR). Health volunteers were available to advocate participation and to provide support to study participants in respect of pedometer wear and reporting activities in the PAR. A qualitative study was conducted as part of the investigation to gain insights on physical activity measurement using pedometers in Vietnam.

8.3 Major findings and implications

The NCD risk profile of people living in the Mekong Delta, Vietnam

This thesis presents information on the NCD risk profile of people living in the Mekong Delta of Vietnam. It is the first time such information has been collected using internationally standardised methodology. Firstly, it shows the remarkable differences between tobacco and alcohol use in men compared to women (68% of men vs. 1% of women were current smokers), highlighting the need for gender specific measures to address these behaviours. Secondly, despite the availability of local fruit and vegetables, the consumption of these types of food appeared to be low, with approximately 70% of men and women not meeting the WHO recommendation of five servings of fruit and vegetable per day. Thirdly, substantial percentages of men (32%) and women (40%) were classified as inactive when physical activity was measured using GPAQ. Work activity constituted 80% of total moderate and vigorous activity. Leisure time physical activity accounted for less than 5% of total moderate and vigorous activity. Lastly, while elevated BG was not highly prevalent in this predominantly rural sample (1% of men and 1% of women had BG exceeding 6.1 mmol/L) when compared to the higher percentages found in big city studies, hypertension was more common (27% of men and 16% of women were hypertensive). The lower prevalence of obesity and physical inactivity in this rural sample helped explain the lower prevalence of elevated BG but were not helpful in explaining the higher prevalence of hypertension. This suggests that there may be other risk factors involved in the rural population, possibly a high salt consumption. Future studies to clarify these issues are required and warranted.

Reliability and validity of physical activity questionnaires in Vietnam

The GPAQ was designed as an improvement of IPAQ in measuring physical activity of populations in developing countries. This study shows that both GPAQ and IPAQ have modest reliability and validity in estimating physical activity in Vietnam. In particular, whilst having some improved performance for those who had stable work patterns, GPAQ measured poorly the activity of those with unstable work patterns. Furthermore, GPAQ appeared to underestimate physical activity of women, because their total activity was only half that of men when measured by GPAQ but almost identical to that of men when measured by other instruments. In addition, physical activity measured by GPAQ correlated poorly with CVD risk indicators for women in this sample. Overall, the GPAQ modification of IPAQ improved its reliability and validity in measuring physical activity for those with stable work patterns, but 21% of men and 57% of women of this rural population had unstable work patterns and further modifications will be required to the instrument to reduce measurement error for this group.

Using pedometers to estimate ambulatory physical activity in Vietnam

It was feasible to use pedometers to obtain a reasonably valid estimate of physical activity in the Vietnamese population. In a study requiring seven days of pedometer wear, 97.6% of participants provided at least one day of usable recordings, and 98% wore pedometers for at least three days. Only 5.2% of the sample was involved in work activities not measurable by pedometer. At least three days of recording were needed to obtain a stable estimate of habitual activity irrespective of day of the week. Using a qualitative approach, pedometers were found to be culturally acceptable and participants were cooperative. Health volunteers played a crucial role in ensuring the success of data collection. However, they required intensive training and constant supervision because the levels of enthusiasm varied between individuals.

Tobacco smoking, a potential confounder to the association of physical activity and CVD risk indicators, was associated with hypertension in a dose-response fashion

Tobacco smoking and alcohol intake were associated with physical activity and with CVD risk indicators among men. Smoking was associated with hypertension in a dose-response fashion, characterised as number of years of smoking and pack-years. On the other hand, tobacco use expressed as smoking status was not associated with hypertension. This finding may explain the equivocal results from previous epidemiological studies that have used smoking status as the measure of tobacco exposure.

Physical activity and its association with CVD risk indicators in Vietnam

Total moderate and vigorous activity was associated with body composition, BG and TC for men and with TC for women. These associations were driven by work activity, the main component of total moderate and vigorous activity. This finding underscores the important role of work activity in preventing CVD in this population. It also highlights the need to advocate increased participation in leisure time physical activity to offset decreased work activity levels fall as Vietnam moves to more advanced stages of industrialisation and becomes less dependent on manual labour. Moreover, measuring work activity accurately is critical when making measurements of total activity in a thorough investigation on the effect of physical activity on CVD in this population.

8.4 Recommendations for future research

Reporting of the work undertaken in this thesis has broadened the knowledge of physical activity measurement in Vietnam and contributed significantly to the understanding of the NCD risk profile of the rural population of Vietnam. Furthermore, it has brought to light several gaps that need to be filled by future research. These gaps are listed below:

1. Differences between the risk profile of this rural dominant sample and that of more urban Vietnamese samples need to be explained. Understanding what underpin these differences will help public health authorities to plan NCD intervention strategies. Those strategies may need to be tailored to take into account the different levels of urbanisation throughout the country.
2. Further development of GPAQ is required to measure physical activity for those with unstable work patterns. In surveys conducted during 2009-2010 in eight provinces of Vietnam by the NCD office of the Ministry of Health, as part of the project to develop a national surveillance system, participants who have more than one work pattern have been allowed to report their activities in each pattern separately, together with the proportion of time spent on each pattern (i.e. number of months in a year). Further testing to confirm the reliability and validity of this modified GPAQ is needed.

3. The generally poorer performance of physical activity questionnaires in measuring activity by women need to be further investigated.
4. The possibility of manufacturing water-proof pedometers should be explored. Although it is feasible to use pedometers in Vietnam, a small portion of the population still have activities that involve contact with water and cannot be measured by pedometers.
5. More research to identify Metabolic Equivalent Task (MET) values for common activities in populations from developing countries is needed. The Compendium of Physical Activities (107), which provides MET intensities for common activities in the US, has been a valuable resource for researchers worldwide who wish to weight physical activity by levels of effort. However, many of the activities performed by people in developing countries are very different from those listed in the Compendium, and this may result in misclassification.
6. The dose-response association between cumulative indices of tobacco smoking and hypertension for female smokers need to be investigated. In this thesis, the association between tobacco smoking and hypertension was examined for men. Such association in women could not be investigated because of their low prevalence of tobacco use. Further studies to investigate this association in other populations with different CVD risk profiles and higher proportion of female smokers are needed.

8.5 Conclusions

This thesis evaluated the use of a range of physical activity measurements in the Vietnamese population. In relation to self-report measurements of physical activity, the GPAQ modification of IPAQ has been only partly successful. Further modifications are needed to produce a culturally relevant instrument. Pedometers can be used to obtain a reasonably valid estimate of physical activity and should be encouraged. The pedometer measurement should involve at least three days of pedometer wear, irrespective of day of the week. In terms of risk factors for NCD in this population, a substantial proportion of the population was inactive when physical activity was measured by GPAQ. The risk profile of this rural dominant sample appeared to be different to those of big city samples, with lower prevalence of elevated BG but higher prevalence of hypertension.

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Prevalence of risk factors for non-communicable diseases in the Mekong Delta, Vietnam: results from a STEPS survey

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Abstract

Background: Despite the increasing burden of non-communicable diseases (NCD) in Vietnam, information on the prevalence of preventable risk factors for NCD is restricted to the main urban centres of Ha Noi, and Ho Chi Minh City (HCMC). This population-based survey aimed to describe the prevalence of risk factors for NCD in a rural Vietnamese sample.

Methods: This survey was conducted using the WHO "STEPwise approach to surveillance of non-communicable diseases" (STEPS) methodology. Participants (n = 1978) were residents of the Mekong Delta region selected by multi-stage sampling. Standardised international protocols were used to measure behavioural risk factors (smoking, alcohol consumption, fruit and vegetable consumption, physical activity), physical characteristics (weight, height, waist and hip circumferences, blood pressure – BP), fasting blood glucose (BG) and total cholesterol (TC). Data were analysed using complex survey analysis methods.

Results: In this sample, 8.8% of men and 12.6% of women were overweight (body mass index (BMI) $\geq$ 25 kg/m^2) and 2.3% of men and 1.5% of women were obese (BMI $\geq$ 30 kg/m^2). The prevalence of hypertension (systolic BP $\geq$ 140 mmHg and/or diastolic BP $\geq$ 90 mmHg, or taking medication for hypertension) was 27.3% for men and 16.2% for women. There were 1.0% of men and 1.1% of women with raised BG (defined as capillary whole BG of at least 6.1 mmol/L).

Conclusion: We provide the first NCD risk factor profile of people living in the Mekong Delta of Vietnam using standardised methodology. Our findings for this predominantly rural sample differ from previous studies conducted in Ha Noi and HCMC, and suggest that it is inappropriate to generalise findings from the big-city surveys to the other 80% of the population.

Background

Despite the increasing burden of non-communicable diseases (NCD) in Vietnam [1,2], information on the prevalence of preventable risk factors for NCD is restricted to the main urban centres of Ha Noi [3-6], and Ho Chi Minh City (HCMC) [7-10]. Taken together, these studies paint an incomplete picture of the NCD risk factor profile of the Vietnamese people. In particular, there is a critical lack of information for the 80% of the population living outside the industrialised areas in and around Ha Noi in the North and HCMC in the South. With the exception of a study conducted in Bavi [5,6], a poor district of Ha Noi, little is known about the NCD risk factor profiles of people living in rural areas of Vietnam.

Home to 21 percent of the country's population, the Mekong Delta - literally the "nine dragon river delta" - is the far southern region of Vietnam. The tributaries of the Mekong River act as a transport network and deposit alluvium, increasing the fertility of the soil that produces abundant harvests of rice and other crops [11]. The river system is also a significant source of food to the population via the fish it supplies. While the Mekong Delta is the main food production area of the country, health services in this region (assessed as number of hospital beds and number of health personnel per 100,000 people) are below the country average [12]. There are no studies apart from our own work that investigate the prevalence of NCD risk factors among residents of the Mekong Delta. Presenting the NCD risk profile for this population would provide the first systemic information of its type to compare with that of other regions and to serve as a baseline for future studies. Moreover, this information will help local authorities to prioritise the health service and health promotion interventions in the region.

This study aimed to describe the prevalence of risk factors for NCD in a rural Vietnamese sample from the Mekong Delta using standardised survey methodology developed by the World Health Organization (WHO) - the STEPwise approach to surveillance of non-communicable diseases (STEPS) [13]. In addition, we compare estimates for men and women in this sample, and our results to those of previous surveys conducted in the two big cities and discuss possible explanations for the differences found.

Methods

Subjects and sampling

This population-based survey was conducted among 25-64 year old residents of Can Tho in the Mekong Delta, Vietnam. Eligible subjects were selected by multistage sampling with age, sex, and urban/rural stratification. In brief, the sampling process was as follows. At the first stage, a sample of eight urban- and eight rural-classified communes was selected with probability proportional to size and with replacement. The second-stage sampling units were health volunteers who are responsible for providing basic health services for residents living in their local area. The health volunteers maintain and update the lists of these people regularly. Collectively the health volunteers cover all households in each commune. One health volunteer was chosen from each selected commune with probability proportional to size of the population for which they were responsible and with replacement. Health volunteers who were responsible for only a small number of households were combined prior to sampling. At the third stage, persons were selected from the list of each selected health volunteer, with stratification for age (we sought equal numbers in the four age categories 25–34 years, 35–44 years, 45–54 years, and 55–64 years) and sex (we sought equal numbers of men and women). The target number of participants in each commune was 125. People who were institutionalized at the time of data collection were excluded. The sample of eligible subjects consisted of 2683 persons of whom 73.7% (1978/2683) participated in this survey.

Informed consent was obtained from participants. Those who could not sign provided verbal consent. The study was approved by the Ethics Committee of Can Tho University of Medicine and Pharmacy. Data collection was carried out from July to November 2005.

Measurements

Measurements by questionnaire consisted of demographic characteristics, socio-economic factors, and four behavioural risk factors (smoking, alcohol consumption, fruit and vegetable consumption and physical activity). The questionnaire was modified with expanded and optional questions to suit local needs. Extended questions were questions in the STEPS instrument modified by adding locally relevant response options (that described types of work specific to the local area, for example). Optional questions were new questions added to the instrument because they were deemed locally important (in relation to passive smoking, for example). All the modifications were done in accordance with the WHO STEPS manual [13]. The questionnaire was translated into Vietnamese and back-translated by independent translators to ensure the appropriate meaning of each item was retained.

Physical measurements included weight (in bare feet without heavy clothing measured using Seca 767 digital scales), height (in bare feet without headwear measured using a Seca 220 stadiometer), waist circumference (at the narrowest point between the lower costal border and the iliac crest measured using a constant tension tape), hip circumference (at the greatest posterior protuberance of the buttocks measured using a constant tension tape), and blood pressure (at the midpoint of the right arm after participants had rested for at least five minutes measured using an Omron T9P digital automatic blood pressure monitor). Two blood pressure readings were obtained for all participants. A third reading was taken if there was a difference of more than 25 mmHg for systolic blood pressure (SBP) or 15 mmHg for diastolic blood pressure (DBP) between the first two readings. The mean of all measures was used.

Biochemical measures included fasting total cholesterol (TC) and fasting blood glucose (BG) measured in capillary blood using a Roche Diagnostics Accutrend Glucometer.

Data collection staff were medical doctors, laboratory technicians and medical students. They underwent intensive training and supervision provided by the Menzies Research Institute. A pilot study was conducted to test survey instruments and procedures before actual data collection. Questionnaires were administered by face-to-face interviews. All measurements were performed in accordance with the WHO STEPS protocols [13] at a clinic set up at 16 different field testing sites.

Statistical methods

Data were coded and presented according to WHO guidelines [13]. Hours of physical activity of moderate and vigorous intensities were weighted by their Metabolic Equivalent Task (MET) values provided in the WHO guidelines (moderate activity is assigned a MET of 4 and vigorous activity is assigned a MET of 8). Analyses were performed using STATA software version 9.2. Complex survey analysis methods were used to estimate the prevalence of study factors taking into account the sampling design and the sampling weight of each participant. A sampling weight for each participant was calculated as the inverse of the probability of selection of that particular participant taking into account each stage of the sampling process. The age structure of the Vietnamese population from the 1999 census [14] was used to estimate the age-standardised prevalence of hypertension. In regression analyses, we investigated whether differences between men and women in change in SBP, BG and TC with age could be explained by differences in the four behavioural risk factors or BMI.

Results

The sample was dominated by persons of Vietnamese ethnicity with Chinese and Khmer in the minority. The majority of participants (particularly women) did not complete secondary school to grade 9, and most were self-employed. The most common occupation (particularly among men) was farming. Selected characteristics of the participants are shown in Table 1.

Table 2 presents prevalence of behavioural risk factors for men and women. Reflecting cultural practice, the prevalence of smoking and alcohol consumption were much higher in men than in women. Additionally, 80.8% (730/910) of men and 50.6% (526/1066) of women reported being exposed daily to tobacco smoke either from themselves or someone else. The average time spent doing moderate and/or vigorous physical activities was 20.47 (95%CI: 15.96–24.98) hours/week for men and 16.27 (95%CI: 13.73–18.80) hours/week for women. The average time spent in sedentary activity was 3.83 (95%CI: 3.26–4.40) hours/day for men and 3.37 (95%CI: 2.81–3.92) hours/day for women.

The results of pathophysiological measurements are presented in Table 3. The mean BMI was 21.2 (95%CI: 20.6–21.9) kg/m^2 for men and 21.5 (95%CI: 21.2–21.8) kg/m^2 for women. The proportions of excess body weight (BMI $\geq$ 25 kg/m^2) for male and female participants in this sample were 11.1%, and 14.1%, respectively. Using the WHO recommended cut point for Asian populations, 23.6 (95% CI: 15.4–31.8) % of men and 31.8 (95%CI: 28.7–34.9) % of women in this sample were overweight or obese (BMI $\geq$ 23 kg/m^2). The mean waist circumference was 75.0 (95%CI: 73.0–77.1) cm for men and 72.2 (95%CI: 71.2–73.3) cm for women. The proportion of abdominal obesity (waist circumference $\geq$ 90 cm for men or waist circumference $\geq$ 80 cm for women) was 7.7 (95%CI: 4.4–11.0) % for men, 17.8 (95%CI: 15.3–20.3) % for women, and 12.9 (95%CI: 10.0–15.8) % for both sexes combined. The mean SBP was 128.4 (95%CI: 126.5 – 130.4) mmHg for men and 120.1 (95% CI: 118.3–121.8) mmHg for women. The mean fasting BG was 3.62 (95%CI: 3.44–3.81) mmol/L for men and 3.65 (95%CI: 3.47–3.82) mmol/L for women. The mean fasting TC was 4.44 (95%CI: 4.30–4.58) mmol/L for men and 4.66 (95%CI: 4.56–4.75) mmol/L for women.

Table 4 shows the estimates of pathophysiological risk factors in the four age groups sampled. More strongly for men than for women, mean levels of BMI ($p < 0.001$), and – adjusted for BMI – means levels of BG ($p = 0.137$) and TC ($p < 0.001$) increased with age. Mean levels of SBP adjusted for BMI also increased more strongly ($p = 0.036$) for women than for men, but from a lower level and did not overtake mean SBP of men even among 55–64 year olds. Adjusted also for the behavioural risk factors (smoking, alcohol, fruit and vegetable consumption and physical activity), the difference in trends remained stronger for women (SBP $p = 0.031$, BG, $p = 0.009$, TC $p = 0.014$).

More men (27.3%) than women (16.2%) were hypertensive (SBP $\geq$ 140 mmHg and/or DBP $\geq$ 90 mmHg, or taking medication for hypertension). Only 29.2% of hyperten-

Table 1: Characteristics of study participants in Can Tho, 2005.

	Men (N = 911)		Women (N = 1067)		p
	%	n	%	n	
Age					
25–34	17.2	157	18.8	201	
35–44	26.9	245	27.4	292	
45–54	29.6	270	28.2	301	
55–64	26.2	239	25.6	273	*0.003*
Ethnicity					
Vietnamese	92.2	839	91.0	970	
Chinese	1.5	14	2.3	24	
Khmer	6.2	56	6.8	72	
Others	0.1	1	0	0	*0.059*
Education completed					
< Primary school	38.0	346	55.6	593	
Primary school	27.5	250	21.1	225	
Secondary school	17.8	162	11.9	127	
High school*	10.9	99	7.2	77	
College/University†	5.8	53	4.1	44	*0.002*
Employment status					
Employed	13.1	119	7.4	79	
Self-employed	62.4	568	50.2	535	
Non-paid/student	0.6	5	0.8	8	
Homemaker	0.8	7	25.5	272	
Retired/unemployed‡	7.0	64	4.7	50	
Unstably employed§	16.2	147	11.4	122	*<0.001*
Occupation					
Farmers	35.9	362	24.1	294	
Industrial workers	9.4	73	2.6	16	
Clerks	9.6	66	7.2	58	
Traders	13.8	107	23.7	227	
Homemakers	0.0	0	22.4	257	
Others	31.3	302	20.0	214	*<0.001*

* High school or equivalent (technical school).
† College or university degree or higher.
‡ Including 12 men and 6 women who were disabled.
§ People who did physical work and got paid on a daily basis.
There were one man and one woman who provided only information on age and sex.

sive men, but 56.6% of hypertensive women, were aware of their condition. The prevalence of hypertension increased with age for both men ($p < 0.001$) and women ($p < 0.001$) (Figure 1). The age-standardised prevalence of hypertension was 26.7% for men and 15.9% for women.

The associations between BMI and hypertension are presented in Figure 2. Hypertension prevalence increased linearly with BMI ($p = 0.020$ for men and $p < 0.001$ for women) after adjustment for age. For each unit of BMI increase, the odds of having hypertension increase by 11% (95%CI: 2–20%) for men and 17% (95%CI: 11–23%) for women. In each BMI category, there was a higher proportion of hypertensive men than women even after adjusting for age.

Discussion

This is the first population survey using internationally standardised protocols to report the prevalence of risk factors for NCD in the Mekong Delta, Vietnam. Previous surveys on NCD have been conducted in Ha Noi and HCMC. There have been some data reported for the population of Bavi [5], an extremely poor district of Hanoi [15], but the findings from this study are unlikely to represent the risk profile of the population of the Mekong Delta where income is much higher and land holdings are much larger.

The first principal finding of this study was that older women in this population-based representative sample generally had an unfavourable NCD risk profile. The sex

Table 2: Prevalence of behavioural risk factors for NCD* in Can Tho, 2005.

	Men (N = 910)		Women (N = 1066)	
	% ± SE†	n	% ± SE†	n
Smoking				
Current smoker	67.8 ± 1.8	631	1.1 ± 0.5	16
Daily smoker	63.1 ± 2.2	594	0.6 ± 0.3	10
Non-daily smoker	4.6 ± 0.9	37	0.4 ± 0.2	6
Ex-smoker	13.0 ± 1.1	130	0.1 ± 0.1	3
Never smoker	19.2 ± 1.6	149	98.8 ± 0.6	1047
Alcohol consumption				
Ever consume alcohol	87.2 ± 1.7	794	11.6 ± 1.0	127
Consume last 12 months‡	80.9 ± 1.9	718	9.3 ± 0.8	104
Consume weekly	39.9 ± 1.8	345	0.8 ± 0.5	12
Consume 5 days last week§	6.6 ± 1.3	84	0.4 ± 0.2	6
≥ 5 drinks any day‖	38.6 ± 2.7	330	0.4 ± 0.2	7
Fruit & vegetables				
5+ servings/day	30.2 ± 2.1	243	26.5 ± 3.0	238
Physical activity¶				
Low (<600 MET-mins)	32.7 ± 5.3	281	40.4 ± 2.4	405
Moderate (600–2999 MET-mins)	16.7 ± 2.2	171	24.2 ± 1.4	247
High (3000+ MET-mins)	50.6 ± 5.3	452	35.4 ± 3.1	396

* Non-communicable diseases.
† Standard errors.
‡ Consume alcohol in the last 12 months.
§ Consume alcohol on at least 5 days in the past 7 days.
‖ Consume 5 drinks or more on any single day in the last 7 days.
¶ Moderate and/or vigorous activity in a typical week.

differences in SBP and TC persisted after adjustment for BMI. This has not been reported previously for Asian populations, but it mirrors reports for some Western populations that blood pressure and TC of men and women converge with advancing age [16-18]. For BG, we found a statistically significant stronger cross-sectional increase with age for women that was diminished by adjustment for BMI but strengthened by additional adjustment for behavioural risk factors. This cross-sectional pattern of increasing levels of BG with age for women, and higher levels for women at older ages, appears not to have been reported previously. Factors not measured in this survey, and which may account for the elevated risk among women, were hormonal status, saturated fat consumption and salt intake.

The second principal finding was the risk profile of this predominantly rural population of Vietnam was markedly different to that reported previously for the two major cities. The prevalence of raised BG (defined as capillary whole BG of at least 6.1 mmol/L) in our sample (men: 1.0%, women: 1.1%) are lower than prevalence estimates reported for the big city convenience samples: 2.7% for men and 2.6% for women aged 20–60 in HCMC in 2004 [8], 4.6% of men and 5.8% of women in the subset of participants aged 25–64 in another sample of HCMC population in 2001 [7], and 5.8% of 20–74 years old residents in Ha Noi in 2005 [4]. A possible explanation for these differences lies in the higher proportion of overweight and obesity observed in the big city surveys. The proportions of obese (BMI at least 23 kg/m^2) participants in our sample (men 23.6%, women 31.8%) were lower than that reported for the Ha Noi sample (33.7%) [4], fewer participants in our survey (12.9%) than in the Ha Noi sample (17.5%) [4] had abdominal obesity (waist circumference ≥ 90 cm for men or waist circumference ≥ 80 cm for women). In the HCMC sample, 18.6% of participants had BMI at least 25 kg/m^2 but only 12.7% (men 11.1%, women 14.1%) of our participants exceeded this level [7]. In the rural sample of Ha Noi from Bavi, only 3.5% of participants had BMI at least 25 kg/m^2 [5]. Another possible explanation for the higher prevalence of raised BG in the big city samples is the lower levels of physical activity among the urban residents. There was 46.6% of men and 41.3% of women aged 25–64 in a HCMC sample in 2005 [9] classified as having a low level of physical activity compared to 32.7% of men and 40.4% of women in our samples.

Table 3: Prevalence of pathophysiological risk factors for NCD* in Can Tho, 2005.

	Men (N = 910)		Women (N = 1066)	
	% ± SE†	n	% ± SE†	n
Body mass index				
<18.5 kg/m^2	16.8 ± 2.8	174	17.4 ± 1.9	172
18.5–19.9 kg/m^2	21.8 ± 2.1	201	18.6 ± 1.5	169
20.0–22.9 kg/m^2	37.8 ± 2.4	327	32.2 ± 2.4	354
23.0–24.9 kg/m^2	12.5 ± 2.4	112	17.7 ± 0.9	192
25.0–29.9 kg/m^2	8.8 ± 2.1	83	12.6 ± 1.1	155
30+ kg/m^2	2.3 ± 1.2	10	1.5 ± 0.4	22
Hypertension‡				
Yes	27.3 ± 2.5	320	16.2 ± 1.5	280
No	72.7 ± 2.5	590	83.8 ± 1.5	786
Blood glucose				
<6.1 mmol/l	99.0 ± 0.6	856	98.9 ± 0.2	1014
6.1–7.0 mmo/l	0.6 ± 0.5	5	0.3 ± 0.1	8
7.0+ mmol/l	0.4 ± 0.2	3	0.8 ± 0.2	16
Total cholesterol				
<5.2 mmol/l (200+ mg%)	85.5 ± 2.4	730	79.1 ± 2.1	770
5.2+ mmol/l (200+ mg%)	14.5 ± 2.4	136	20.9 ± 2.1	268

*Non-communicable diseases.
† Standard errors
‡ Systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg or taking medication for hypertension.

Table 4: NCD* risk factor estimates by age group and sex in Can Tho, 2005.

	BMI‡ Mean(SE)	SBP‡ Mean(SE)	BG§ Mean(SE)	TC‖ Mean(SE)
Men				
25–34	21.4(0.6)	126.0(1.7)	3.56(0.08)	4.39(0.09)
35–44	21.2(0.2)	125.0(1.2)	3.64(0.09)	4.37(0.06)
45–54	21.3(0.3)	134.3(1.3)	3.75(0.10)	4.57(0.08)
55–64	20.8(0.3)	140.0(1.5)	3.65(0.10)	4.66(0.06)
p for trend¶	*p = 0.543*	*p < 0.001*	*p = 0.015*	*p = 0.008*
Women				
25–34	20.5(0.2)	114.3(1.0)	3.49(0.10)	4.46(0.08)
35–44	21.4(0.3)	116.5(1.3)	3.61(0.10)	4.45(0.05)
45–54	22.9(0.3)	129.3(1.0)	3.87(0.09)	4.99(0.07)
55–64	22.6(0.3)	136.6(1.8)	3.93(0.12)	5.26(0.10)
p for trend¶	*p < 0.001*	*p < 0.001*	*p < 0.001*	*p < 0.001*

* Non-communicable diseases.
† Body mass index.
‡ Systolic blood pressure.
§ Blood glucose.
‖ Total cholesterol.
¶ p for trend adjusted for age.

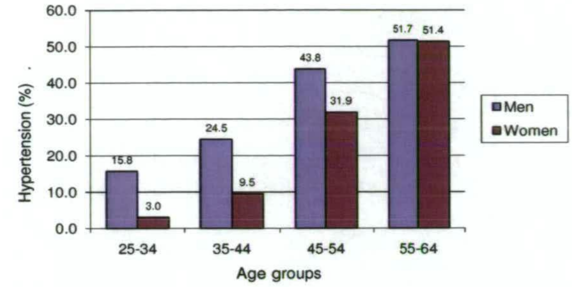

Figure 1
Prevalence of hypertension by age group in Can Tho, 2005.

In contrast to raised BG, the proportions of participants in our sample with hypertension (27% of men and 16% of women) exceed the prevalence estimates reported for the big city surveys. Hypertension was identified among 21% of men and 10% of women in a sample of 25–64 year olds from a single commune in Ha Noi in 2007 [3], 17.5% for the subset of 20–59 year old participants of a convenience sample from two districts of Ha Noi in 2005 [4], and 11% for men and 9% for women aged 20-60 in HCMC [8]. Our results are more similar to those reported for the extremely poor rural sample of Ha Noi from Bavi [5] in 2005 (24% for men and 14% for women aged 25–64) in which the prevalence of overweight and obesity was less than a third of that found this study. Dietary sodium intake has been linked with hypertension [19], and salt consumption may be higher in poor rural areas where it is used to add flavour to rice. No published study to date has measured dietary sodium levels in a Vietnamese population, however, and this contention remains unsupported. Alcohol has been shown to be associated with elevated blood pressure [20]. Our prevalence estimates of alcohol

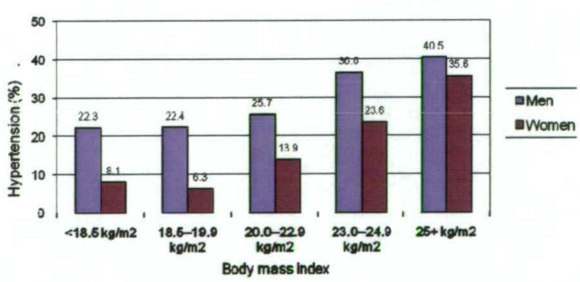

Figure 2
Association between body mass index and hypertension in Can Tho, 2005.

consumption are the only published Vietnamese data, and, therefore, no comparisons are possible. Tobacco smoking has been associated with elevated blood pressure in another study from this region [21]. The limited data on smoking prevalence in Vietnam show relatively minor variation through the country. In our sample, 67.8% of men and 1.1% of women were current smokers. In a HCMC sample of 20–60 year olds, 62.2% of men and 1.4% of women were current smokers in 2004 [8] and 62.9% of men and 0.6% of women were current smokers in the Bavi sample [5].

A key strength of this study was its use of a representative sample, with analysis done taking into account the complex survey design. The relatively high response proportion minimises the likelihood of selection bias, and the range and quantum of factors that were measured should be a good reflection of those factors in the Vietnamese population. The use of WHO standardised protocols, intensive training of data collection staff, pre-study testing of procedures, and the close supervision of staff during data collection, all highlight the attention that was paid to minimising avoidable sources of measurement error.

Limitations of this study need to be borne in mind. The STEPS methodology is designed to provide standardised information on key modifiable risk factors that can be measured in population-based surveys without resort to high technology instruments. It is not designed to measure total energy intake, dietary fat, dietary sodium, body fatness, or physical activity by objective methods such as accelerometry and pedometry. Information on these factors would have provided a more comprehensive picture of the relationships we studied. In addition, these cross-sectional data do not allow age-related differences in blood pressure, BG and TC to be attributed to ageing independently of cohort effects.

Conclusion

This study provides the first NCD risk factor profile of people in the Mekong Delta of Southern Vietnam using internationally standardised methodology. Our findings for this predominantly rural sample differ from previous studies conducted in Ha Noi and HCMC, and suggest that it is inappropriate to generalise findings from the big-city surveys to the more than 80% of Vietnamese people who live outside the two commercial centres.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

All authors provided input into drafts and approved the final draft of the manuscript. In addition, PHL contributed to the design of the study and data acquisition; ABT contributed to the design of the study, data acquisition, data analyses and interpretation; LB contributed to the design of the study, data acquisition, data analyses and interpretation, and provide statistical expertise; TBN contributed to the design of the study and data acquisition; MDS contributed to data analyses and interpretation; RHG contributed to the design of the study; TD contributed to the design of the study. All authors read and approved the final version of the document.

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